HYGIENE

AND

PUBLIC HEALTH

R. C. RAY, L.M.S.

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OUTLINES OF

HYGIENE AND PUBLIC HEALTH

FOR STUDENTS SANITARY OFFICERS
AND PRACTITIONERS

BY

RAMES CHANDRA RAY, L.M.S.

Member of the Governing Body, Belgachia
Medical College, Calcutta.

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PREFACE.

This little book is intended to be a companion to its predecessor, "Outlines of Medical Jurisprudence," so as to complete the subject of State Medicine. I have written this book with a special eye to tropical, and particularly Indian, conditions and have meant the book to be used advantageously by the university candidate during his pupilage and by him as a practical sanitarian during the practice of his profession. Sanitation now looms large in the university curriculum as well as in the daily practice of the medical profession and I have made every endeavour to make the subject as interesting as I could.

Written in the intervals of professional work, shortcomings are likely to be met with here and there ; but, if the work, such as it is, should prove useful, I shall endeavour to make improvements in future editions. Gentlemen feeling an interest in this kind of attempt would be welcome to make suggestions for improvements where improvements may be made and corrections where there are errors.

Students reading this book for their University Examinations may omit paragraphs and chapters printed in small types.

36, AMHERST STREET,
Calcutta, 4th July, 1917.

R. C. RAY.

TO

THE SACRED MEMORY

OF

MY MOTHER.

HARE PHARMACY. 37, AMHERST ST. CALCUTTA.

OUTLINES OF
MEDICAL JURISPRUDENCE
AND TREATMENT OF POISONING

BY

RAMES CHANDRA RAY, L. M. S., (CAL. UNIV.)

Emeritus Lecturer on Forensic Medicine, College of Physicians & Surgeons of Bengal.

Fourth Edition

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TERMS

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CONTENTS.

Introduction CHAPTER I. 1
Air : CHAPTER II. Composition—Impurities—Air-borne diseases—Vitiation of air 4
CHAPTER III. Ventilation—Examination of air ... 26
CHAPTER IV. Warming—Cooling—Lighting 48
CHAPTER V. Nuisances of trade—Dangerous trades ... 56
Water : CHAPTER VI. Composition—Sources of supply ... 65
CHAPTER VII. Quantity required—Storage—Distribution... 82
CHAPTER VIII. Impurities—Purification—Examination... 91
Soil : CHAPTER IX. General considerations—construction of Dwellings—Special Dwellings 115
Food : CHAPTER X. General introduction 138
CHAPTER XI. Sources and Varieties of food stuffs—Animal food 143
CHAPTER XII. Vegetable food 154
CHAPTER XIII. Food Accessories 167
CHAPTER XIV. Fuel value of food-stuffs—Diet calculations —Amount of Nitrogen necessary—Diet in India—Infant feeding 118
CHAPTER XV. Cooking—Invalid and Sick Dietary—Diseases in connexion with food—Control of milk supply 192
CHAPTER XVI. Food Adulteration—Food Inspection—Analysis of food-stuffs—Eating Houses 201
Refuse : CHAPTER XVII. Disposal,—Removal—Construction of Drains 220
CHAPTER XVIII. Sewers 249
CHAPTER XIX. Purification and Disposal of Sewage—Septic Tanks 257
Disposal of the Dead : CHAPTER XX 279
Personal Hygiene : CHAPTER XXI—Cleanliness—Clothing and Dress—Exercise—Rest and Sleep 283

School Hygiene : CHAPTER XXII. 306
Meteorological Instruments : CHAPTER XXIII. ... 325
Climate : CHAPTER XXIV. Theoretical considerations ... 332
CHAPTER XXV. Practical Application of climate in the treatment of the sick... 347
CHAPTER XXVI. Foreign Health Resorts—Springs in India —Climate Gazetteer of India—Hill Sanitaria in India —Sanitaria in Asia 363
Contagia : CHAPTER XXVII. Contagia—Bacteriology—Immunity 394
Infectious Diseases : CHAPTER XXVIII. ... ...
Human Parasites : CHAPTER XXIX. 455
Disinfection : CHAPTER XXX 564
Vital Statistics : CHAPTER XXXI. 478
APPENDICES ; Mathematics of Hygiene 488
INDEX ... ...

Portions useful to Sanitary Officers :

Examination of Air pp. 45—48 ; Stable construction pp. 57—58 ; Slaughter House construction pp. 58—60 ; Market construction pp. 61—62 ; Points for examining &c. Wells, pp. 80—81 ; Examination of water pp. 107—113 ; Hospital construction pp. 136—137 ; Points for inspecting buildings p. 137 ; Control of milk supply, pp. 198—201 ; Food Adulteration, pp. 201—203 ; Food Inspection pp. 203—213 ; Analysis of Food Stuffs pp. 214—218 ; Control of Eating Houses pp. 218—220 ; Purity of Sewage Effluent pp. 276—278 ; School Hygiene pp. 306—325 ; selection of Climates with reference to patients and their diseases, including a Climate Gazetteer of India and the East, pp. 347—323. Insects and Disease. 454—464 Investigation of an Epidemic, pp. 453—454 Practical disinfection pp. 474—478.

Anti - Tuberculosis measures p 426
" Malaria " pp 432-435
" Cholera " pp 441-443

OUTLINES OF

HYGIENE AND PUBLIC HEALTH.

INTRODUCTION.

Definition and Scope.—**Hygiene** takes its name from the Greek goddess of health, Hygeia, daughter of Æsculapius (god of medicine). Along with Medical Jurisprudence, Hygiene forms a part of **State Medicine.** Inasmuch as the object of hygiene is to prevent the accession of diseases, it is also called **General or Preventive Medicine.** It is called **Sanitary Science** (from sanitas=health), for, it seeks "to make growth more perfect, decay less rapid, life more vigorous and death more remote."

Medicine, as we understand it to-day, is curative or palliative in its aim; hygiene is preventive. Communities, like individuals, require to live and be healthy; otherwise, the loss to the State in money, in brain power, in physical labour, caused by prolonged suffering and death of inhabitants from preventable diseases would be enormous. Hence, sanitation is one of the prime cares of the State.

Achievements of Hygiene.—Sanitary measures have banished from England her former scourges, malaria, leprosy, typhus and plague. Sanitation has taught us how to prevent scurvy, small pox, plague and other infectious diseases. Sanitation has made Calcutta healthy, by banishing malaria, cholera and dysentery from it. And sanitation has made plantation colonies possible in various parts of the tropics. It is a comparatively young but progressive science and is always achieving newer conquests.

Divisions of the subject.—Broadly speaking, hygiene is divided into three divisions—(1) **Personal** hygiene, as it affects individuals with respect to their habits, clothing, exercise, rest, sleep &c. ; (2) **Public** hygiene—relates to State control of water-supply, disposal of refuse &c. ; and (3) **General Preventive medicine**—meant for individuals as well as communities—treats of diseases that are contagious or due to insects.

To be an efficient sanitarian, one must know something of sanitary *laws*, one must be well read in *medicine* and one must know sanitary *engineering* too. A good grounding in medicine, chemistry and pathology, a practical acquaintance with bacteriology, keen powers of observation, a tactful, sympathetic disposition, ready wit, unflinching honesty and cool level-headed judgment are qualifications essential to a sanitarian.

State control of sanitation.—The State controls the sanitation of a country with the help, and through the medium of, (1) Municipal institutions, (2) Special Sanitary departments and (3) Law and Justice, aided by the police.

Municipalities are charged with (*a*) **supply** of pure drinking water, efficient scavenging and drainage ; and with free supply of vaccination, treatment of paupers and primary education ; (*b*) **prevention** of adulteration of foods, drinks and drugs, contamination of air and of other dangers to public health and safety ; (*c*) **regulation** of buildings, places of amusement, markets, disposal of refuse and of dead bodies ; and (*d*) **maintenance of register** of births and deaths, of vital statistics and of census of population.

Special Sanitary departments are created to control vaccination against small pox, to prepare vaccine lymph, to supply anti-rabic or anti-plague or other specialized inoculations, to serve as tuberculin dispensaries or sanatoria, to carry on scientific investigations &c.

Law & Police.—To enforce all sanitary laws and to prevent the commission of such crimes as may endanger public health and safety, the entire police and judicial machinery are called into aid. In cases of sudden and temporary overcrowding (as, during fairs &c.) or of sudden outbreaks of infectious diseases, the help of the police is freely required to control the crowd, to guard water from becoming polluted and to enforce isolation, segregation or quarantine.

Sanitation in India.—In ancient times, sanitation, in India, was regarded as of so great moment as to have become welded with religion. Col. King I. M. S. remarked truly: "None but men possessed of strong sanitary instincts would have considered it necessary to render it illegal that filth should be brought near them or would have taken care that those following noxious trades, and the "great unwashed" generally, should not approach them. It is true, these sanitary laws are known as "rules of caste"; but neither their origin nor their intention can be mistaken. Were the most recent refinement of scientific research, the bacteriologist, to have it all his own way, I verily believe, we should find ourselves bound down by rules as rigid as those of caste."

But **now-a-days**, things have changed and to-day sanitation is one of the crying needs of India. Idleness born of a belief in fate; increasing poverty, with its inevitable train of malnutrition, squalor and increased vulnerability to diseases; ignorance of the masses, with their superabundant faith in superstitions and charlatanism; jealousy born of a debased joint-family system;—these are some of the factors that have made and are making India insanitary.

When civilization was in its infancy, diseases were freely attributed to the wrath of the gods, to the 'evil eye' of demons, witches and sorcerers, to the malevolent influences of the planets and, at a later date, to the derangement of the 'humours' of the body ; cures were therefore sought by prayers, penances, conjuration and exorcism. But, before civilization dawned elsewhere, India had possessed a system of treatment all her own ; hospitals had existed and medical congresses used to be held periodically to take stock of progress in medicine ; inoculation against small pox was practised and preventive medicine (hygiene) and operative midwifery were as well practised as surgery and dissections. The materia medica was copious ; metals were freely used and their study of the pulse as an index of diseases and prognosis seems yet to be a wonder.

CHAPTER I.

AIR.

Formerly, all gaseous bodies were called air ; now it is limited to the atmosphere.

Necessity for Air : (1) For the **very existence** of plants and animals, air is necessary. Hence, we live in an ocean of air and a man requires on an average 1500 gallons (=187½ maunds) of pure air. (2) For **maintenance of body in health** : diseases and health are in direct proportion to the foulness and purity respectively of air ; this is true of man as well as of animals (cows, horses &c). (3) For the **improvement of health** broken down by other causes—as evidenced by change of air, sea-voyages, ozone treatment &c. (4) For **cure of certain diseases,** *e. g.*, phthisis (by sanatoria treatment).

Pure air—ideally so called—is never to be found. For practical purposes, air is said to be pure when it is free from colour, taste or smell and has the following average—

Composition :—Air is a mechanical* mixture, not a chemical compound, of its components; hence, its composition over local areas may, for short whiles, vary.

The reason why the composition of the entire bulk of air, all over the universe, remains uniform is the combined action of (*a*) the diluting and sweeping **winds,** (*b*) the dissolving **rain,** (*c*) the oxidising action, on organic matters, of **oxygen** and **ozone,** (*d*) the combined action of **sun light** and **chlorophyll** of plants and (*e*) the diffusion of gases.

(*a*) **Fixed constituents.**

Oxygen	209·6	sq. ft.	(the essential element)
Nitrogen	782·1	,,	(diluents of oxygen)
Argon	7·9	,,	
Carbon dioxide	0·4	,,	

(*b*) **Variable constituents.** Aqueous vapour, neon, helion, metargon, krypton, xenon, hydrogen, ammonia, ozone, organic matter, mineral salts, nitric acid, micro-organisms.

Note that the proportion of oxygen to nitrogen is 1 : 4 in atmosphere; but 1 : 1·87 in air dissolved in water.

---

* *Proofs that air is a mechanical mixture* : (1) The relative components mixed in the actual proportions resemble air and no manifestation of heat, electricity or change of volume occurs in consequence. (2) The relative amount of the components cannot be expressed in a formula. (3) They do not exist in air in the proportion of their combining weights or any multiples thereof (4) Air that is dissolved in water contains a quite different proportion of its natural components.

A comparative study of the principal constituents of air :—

Name of components.	Chemical properties.	Usual percentage by volume or by weight.	Whence or how obtained.	Physical properties.	Tests.
Oxygen, O	Supports combustion (life); irrespirable when pure	20·94% by vol. 23·10% by wt.	Green leaves, soil; Increased actually by vegetation, relatively by rain.	Colourless	Heat metallic oxides or peroxides in it.
Nitrogen, Azote, N [1% N = Argon]	Does not support combustion or life; is a plant food.	79.02% by vol. 76·82% by wt.	Abundant in nature and in all animal and plant tissues.	Colourless, tasteless, odourless. Dilutes oxygen in air.	(1) Pass air over red hot Cu. (2) Burn P over H_2O.
Ozone, O_3 [$3\,O_2 = 2\,O_3$]	Oxidises (∴ deodorizes) Irritant to mucous memb.	Less than 1 in 700,000.	By evaporation of water, by thunder, on high altitudes, in pine forests.	Colourless, penetrating odour.	Paper soaked in KI + Starch = blue.
Carbonic Acid CO_2.	Acid, does not support combustion; Is plant food.	0·04% by vol. 0·06% by wt.	By respiration, combustion, putrefaction, fermentation.	Colourless, heavy.	Lime water turns turbid.
Water, H_2O		1 – 1½ % by vol.	From sea or surface-water by evaporation.	Solvent. Keeps all tissues soft.	

Physical Properties of Air :

(1) **Possesses weight.**—1 cub. ft. of dry air at 0°C and 760 mm. of mercury, weighs 556. 85 gr. Assuming the globe to be enveloped by air upto a height of 40 miles, each sq. inch of earth supports 14$\frac{3}{4}$ ℔ weight (pressure) of air.

[Torricelli's experiment :—Weighing a cylinder filled with air and again with all air sucked out, shows that 100 cub. in. of dry air (at 60° F and 30″ in. barometric pressure) weighs 31 grains – air being 773 times lighter than water.

(2) **Is Expansile :** Assuming no change in pressure (or weight, air expands or contracts $\frac{1}{491}$th (= ·00203) of its volume for every degree it is above or below 32°F in temp. **(Charles' Law).**

(3) **Is Diffusible :** (*a*) The force of diffusion is inversely as the sq. roots of the densities of the gases **(Graham's Law).** (*b*) All gases mix with one another, no matter, how they differ in weight. The temperature remaining the same, the 'volume' of a given quantity of air is inversely as the pressure which it bears **(Boyles' law).**

(4) It has neither **colour, taste** nor **smell.**

IMPURITIES OF AIR.

Oxygen is the most important element of the atmosphere, and, although a high percentage of it in the air of a place makes that place proportionately healthier, yet the exact per centage is immaterial in places that are well ventilated. For practical purposes, decrease in the amount of oxygen, with proportionate increase of **carbon dioxide,** water vapour and organic matters renders the air impure. The following, however, constitute all the chief sources of atmospheric impurity.

Classification: (*a*) **Gases**—NH_3, NO_2, volatile organic emanations, CO, more CO_2, CH_4, HNO_3, SO_2, H_2SO_4 (*b*) **Solids** (i) *Inorganic*—sand, coal, soot, NaCl, oxide of iron, clay, dust*, chalk. (ii) *Organic*:—Starch cells, pollen grains, seeds of plants, flax, wool, silk, cotton; scales of hair or skin, fat particles; pus cells, dried sputum or other dejecta; bacteria, moulds, micrococci.

Details about the important impurities of air are:—

Name of Impurity.	Maximum of safety limit.	Effects on the system of man.
Ammonia	3 in 10,000,000	Irritation of eyes and air passages.
HNO_2 (Nitrous) **HNO_3** (Nitric)		Ditto
Carbon dioxide	Over 15 per 1000	Vertigo, dyspnœa, headache (in small doses); convulsion, coma and death (in large doses).
Carbon Monoxide	5 per 1000	Headache, muscular paresis, convulsions.
Marsh Gas (Methane)	300 per 1000	Vomiting, convulsion, headache
H_2S, whence **H_2SO_3**	1 in 70,000	Narcotico-convulsant
Inorganic Solid Impurities		Asthma, Phthisis, Symptoms of poisoning peculiar to each metal, hæmoptysis Ague (nonperiodic)
Organic Solid Impurities Micro-organisms	20 bacteria per litre Bacteria : moulds :: 30 : 1	Infectious diseases specific to each germ.
Organic Emanations		Excites putrefactive process, lassitude, headache, sickness.

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* **Dust**—is not pure mineral matter, but a combination of the same with filth from—streets, sinks, water closets, overused blanket, befouled floors, floor deafening, dirty carpets, unwashed clothes, dirty utensils &c.,—such as, animal droppings, human dejecta, skin.

Bacteria,—found ordinarily in air, are mostly **non-pathogenic**—*e. g.*, chromogenic cinnabareus, c. aurantiacus, c. saccharomyces, sarcina lutea, s. rosea or the bacillus subtilis, b. mesentericus, &c.; the **pathogenic organisms** (*e.g.*, tubercle, diphtheria, influenza &c.) when present, are derived from the inmates of the room; they are not given off in ordinary respiration by men harbouring them in their body but are given off only during coughing, sneezing or loud talking. As a rule, our upper air-passages (nose, tonsils, palate, pharynx &c.) filter the inspired air of any microbes drawn in with the air, to be subsequently hawked out;—hence, air enters lungs more or less sterile. **Bacteria depend for their life and transportation** in air, on dust particles which are large enough to resist complete drying; because, well-sunned dry dust helps to retard growth even of their spores. [Miguel found only one bacterium per cubic metre of high mountain air, 6 bacteria in mid-Atlantic air, 200 on the summit of the Pantheon and 79,000 in a Paris hotel].

Moulds are derived from external air. **The number** of bacteria in comparatively pure air should not exceed 20 per litre and the **proportion between bacteria and moulds** should be as 30 : 1. It is this proportion, rather than the actual number of bacteria, that is more important as signifying contamination—because, the greater the amount of dust, the greater is the proportion between the two and the less the proportion, the greater is the comparative dustlessness.

Carbon Dioxide: **Its significance:** The amount of carbon dioxide present in the air of a locality is a measure of the amount of decomposition of organic matter in that locality—and, therefore, of the extent of air-vitiation.

Quantity present is regulated by what: (*a*) Ordinarily, a healthy man inspires 686,000 cubic feet of air in 24 hours and gives out to the atmosphere, in 24 hours, if at rest, 16 cub. ft., and, if working, 37 cub. ft. of CO_2. Normally, too, the amount of CO_2 is greater in the air of morning and evening than at midday or midnight, more during night than in the day (when the vegetables are absorbing it), more on land than on sea, more at high altitudes than at sea-level, more also before than after rainfall, more in autumn, early winter and spring than in late winter or summer and more during fogs than during sunny weather. (*b*) By interchange between the atmospheric CO_2 and oceanic water giving up CO_2, between the ground air and atmospheric air, between animal and vegetable respirations, between gases of different density. (*c*) Rainfall and wind help to regulate the amount of CO_2 all over the earth. [**Plants** on the whole diminish the atmospheric CO_2 in amount: during the day, green plants decompose the CO_2 of air, fixing or assimilating the carbon and liberating the O; at night, all plants take up oxygen and give off CO_2 (= respiration), thereby vitiating the air. **The sea** dissolves up atmospheric CO_2 when it is in excess; but liberates CO_2 from its dissolved carbonates of lime and magnesia, when that gas is lessened in the atmosphere. The upper layer of **soil** absorbs or disengages CO_2 according as its amount is greater or less than normal in the atmosphere.]

Its presence in excess in the air of a room is detected when it is 0·8 per 1000 volumes of air—**"rather close"**; the air is **"close"** when the total is 1·0 per 1000 volumes of air; and **"very close"**, when 1·2 per 1000 vols. As the sense of smell is quickly blunted by foul air, we cannot perceive beyond this.

Pettenkofer's method of estimating the amount: *See* Appendix.

Ammonia.—Significance: The amount of it present anywhere is a measure of the amount of decomposition of animal matters taking place at the surface. **Its estimation** is effected thus : slowly aspirate 250 litres through a weak solution of hydrochloric acid. Neutralize this with ammonia-free KOH and distil. The distillate is treated with Nessler's reagent and the amount estimated.

Organic Emanations,—when from a human adult, comprise—nitrogenous and oxidisable matters given off by **skin** and **lungs.** These cling to rooms and diffuse very slowly. The presence of these along with carbon dioxide is responsible for the "stuffy" sensation to the breather and deleteriousness of the atmosphere.

Miasma or Marsh Vapour or "mala aria"—is a compound of $H_2O + CO_2 + CH_4 + H_2S + H$. It is not *directly* responsible for malaria but the marshes afford suitable ground for malaria-germ-bearing anopheles mosquitos to lay their eggs on.

Moisture (Humidity).—Its necessity : A certain amount (40 to 60%) of saturation of atmosphere is essential to life, in that it secures greater uniformity of climate and of the heat of the body. Variations in the amount of moisture affect questions of ventilation and warmth. Very moist air adds to the deleterious effects of carbon dioxide present in the atmosphere and leads to ill-health ; very dry atmosphere is uncomfortable. [In 24 hours, the skin and lungs give off 30 to 40 ounces of water.] **Humidity is greater in the airs of**—tropics than of the poles, in summer and rainy season than in winter, at midday than at morning or night, over marshes, rivers and seas (provided the day is hot and still) than on land, at lower than at higher altitudes. **Saturation** means the maximum amount of water that air can take up at a certain temperature—the temperature and not the actual amount of water being of greater moment to our health. Air at 60°F (=4·2 grains aqueous vapour) is less humid than at 10°F (= 1·1 grain); for, air may be saturated at every temperature—but the warmer the air, the greater is the amount of water that air can absorb. Saturation is expressed in terms of the pressure which the aqueous vapour present in the air exerts at the earth's surface, —a pressure proportionate to its weight. **Absolute humidity** is the actual amount of water in a given atmosphere. It is expressed in the same terms as the saturation. **Relative humidity** (at a *given* temperature) is the relation between actual humidity and saturation. **Dew-point** is the temperature at which the moisture present in the air (the absolute humidity) would suffice to saturate it.

Amount of moisture : With atmospheric temperature increasing in arithmetical progression, humidity increases with the rapidity of a geometrical series, having a ratio of 2. **Is determined** *(a)* quickly and only approximately, by the hair hygrometer ; and *(b)* more correctly but slowly and along with estimation of dew-point—by the wet and dry bulb thermometers. The quantity of moisture in wholesome air should not be less than 40°/₀ of saturation.

Modern Sewer Air differs from outside (atmospheric) air in containing—*(a)* 11·8 parts CO_2 per 10,000 volumes of air ; *(b)* less number of micro-organisms ; *(c)* few bacillus coli communis or micrococcus ureae and some staphylococci pyogenes aureus. Sewer air does not convey typhoid fever or tuberculosis, and "as regards organic matter, CO_2 and micro-organisms, air of modern sewers is in a very much better condition than the air of naturally ventilated school rooms!"

Ground air—is atmospheric air plus the products of soil metabolism (decomposition of organic matters). **It differs from atmospheric** air by having—fewer micro-organisms, more moisture, more CO_2 (10 to 160 parts per 1000), humic acid (ammonia), sulphides, CH_4, CS_2. **The amount of CO_2,** in it increases—with (1) depth and (2) decomposition ; (3) in the morning during autumn, and evening during spring ; (4) after a downpour, when the superficial pores of the soil are sealed ; and (5) in hot weather. The CO_2 in soil-air is diminished (and ∴ the **soil is ventilated) by**—cold weather and rain, which can dissolve CO_2 in the upper layers. With depth, the amount of CO_2 increases but that of oxygen and organic matters and chemical changes diminish. Ground air is **constantly in motion**—due to influences of ground water, temperature, barometric pressure, rain, winds etc.—the points of exit being where the ground is not wet—as, under buildings ; hence, with the rise in the amount of ground-CO_2, gastro-intestinal diseases are likely to increase.

AIR-BORNE DISEASES.

(A) **Due to Bacteria** These diseases are communicated from one to another by air carrying their germs :—

(a) **Phthisis**—the bacillus of which is transmissible directly through air or by floating dust, laden with dried sputa. Dark, damp, ill-ventilated dwellings harbour and favour growth of T. B.

(b) **Diphtheria**—communicated directly by cough of a sufferer.

(c) **Catarrh, Bronchitis, Pneumonia, Influenza**—are almost endemic to ill-ventilated areas. The contagion is transmitted directly through the air, from a sick man's breath or infected sewer and drain emanation.

(d) **Accute Tonsillitis** *(e)* **Hospital sore throat** *(f)* **Erysepelas** *(g)* **Ophthalmia** *(h)* **Pyæmia** *(i)* **Septicæmia** *(j)* **Hospital gangrene**—are transmitted by air of vitiated hospital wards.

(*k*) **Parasitic skin diseases** (*e.g.*, those caused by spores of trichophyton tonsurans, achorion schonleinii etc.) are communicable by air.

(*l*) **Acute specific Fevers** (small pox, measles, scarlet fever etc) are transmitted through air.

(*m*) **Epidemic cerebro-spinal meningitis**—is spread by inhaling breath or dust laden with dried nasal secretions of patient.

(*n*) **Anthrax, Whooping cough, Hay asthma, Hay fever, Typhus.**

(B) Due to Dust of Trades and Manufactures : In the carrying out of certain trades, fine dust is given off continuously. If this is regularly inhaled, certain diseases are produced ; thus, work with the following produces the diseases named :—

(1) Earth (in potter)—asthma (emphysema).

(2) Stone (in mill-stone cutters, stone masons, sand-paper makers)—lung diseases.

(3) Pearl—osteitis (rheumatism).

(4) Bone (in button makers)—bronchitis, haemoptysis.

(5) Brass (in founders)—Ague, bronchitis, asthma.

(6) Lead (in painters, potters and manufacturers)—saturnine colic or palsy.

(7) Mercury—Ptyalism.

(8). Coal (in miners)—phthisis, or bronchitis ; (in chimney sweeps)—skin disease or cancer.

(9) Cotton—asthma or phthisis. Rag, hemp and flax (in dresser)—consumption. Wool (in sorters) malignant pustule.

(10) Tobacco (in cigar makers)—Poisoning,

To prevent these use (*a*) wet grinding, (b) steam fans, (*c*) free ventilation (*d*) respirators, (*e*) absolute personal cleanliness.

(C) **Due to Noxious gases given off in factories** :—(*a*) Acid hydrochloric (gas)—from alkali works or electroplating works. (*b*) Acid sulphuric (gas) and Sulphur dioxide—from bleaching and copper melting works. (*c*) Acid chromic in bichromate of potash manufactory. (*d*) Arsenic—(in artificial flower-makers or workers in copper works. (*e*) CO—from iron and copper melting works, brick fields, cement works, lace frame. (*f*) CO_2—from brick fields, brewing vats and cement works. (*g*) CS_2—from india rubber works. (*h*) Sulphuretted hydrogen—from chemical and cement works and brickfields. (*i*) Organic matters—from glue and gelatine factories. (*j*) Phosphorus—from match factories. (*k*) Zinc fumes from brass works. (*l*) Ammonia—in hat-making factories. (*m*) Pot. cyanide—in photographic studios. (*n*) Resinous fumes—in brush factories. (*o*) Smoke, water gas, H_2S, H_2SO_3 etc.—from gas works.

(D) **Due to offensive gases** evolved in trades connected with—(*a*) Blood boiling and drying—for preparing turkey-red, for sugar refining, blood, albumen, or manure preparing. (*b*) Bone boiling—for preparing gelatine, glue, manure, handles. (*c*) Tripe boiling—for food. (*d*) Fat and Tallow melting. (*e*) Soap making. (*f*) Fell mongering. (*g*) Leather dressing and tanning. (*h*) Gut scraping—for preparing sausage or catgut. (*i*) Glue and size making.

[Paper-making, artificial manure making, pig-keeping, knackering and fish-frying are trade nuisances only.]

(E) **Due to continuous inhalation of sewer air.**—(*a*) Sewer-air-throat—a severe form of **tonsillitis**. (*b*) **Blood poisoning**—with petechial rashes, glandular enlargements, lymphangitis, albuminuria, fever. (*c*) **Diarrhœa, Ophthalmia**; **Enteric (?) Aggravation of venereal diseases, Dysentery, Summer Diarrhœs. Puerperal fever, Erysepelas, Pyaemia, Septicaemia.**

VITIATION OF AIR.

Vitiation of air **means** relative reduction of oxygen and increase of other harmful gases.

Air is vitiated by products of: (1) **Respiration** of men and animals, (2) **Combustion** of fuel and illuminants, (3) **Fermentation** and oxidation or **putrefaction** of organic bodies and (4) **Industrial** occupations.

(A) BY RESPIRATION.

Action of Respiration: The lungs contain over six millions of air vesicles (having an aggregate area of 10 to 20 sq. ft.) and can take in, at rest of body, 30 cubic inches of air with each inspiration—or, roughly, 686,000 cub. in. of air in 24 hours. The **total capacity of the lungs** is as follows :—

Tidal (ordinary inspiration)	Air	30	cub. in.
Complemental (forced ,,)	,,	100	,,
Supplemental (forced expiration)	,,	100	,,
Residual (fixed)	,,	100	,,
Total		330	cub. in.

The pure air is taken to every lung-alveolus to be absorbed in part and the following comparative table shows at a glance the gains (+) and losses (−) of the expired air, as compared with ordinary atmospheric air :—

	Inspired air.	Expired air.	Difference.
Oxygen	20·81%	16·033%	−4·777
Nitrogen	79·15%	79·557%	+·407
CO_2	0·4%	4·38%	+3·98
H_2O	Variable	+	+5%
Temperature	Variable	+	98·4°F
Organic impurities	Variable	+	+1½%
Volume of air	Variable	+	+

Exhalations from *skin* (transpiration) consist of water-vapour 20 oz., ammonia and organic matter; the *lungs* contribute, in adults, 10 oz water vapour, 14·4 cub. ft. of CO_2 ($=\frac{1}{2}$℔ pure carbon) and 30 grains of **organic matter** in 24 hours; *i.e.*, each person gives 1·1 part by weight(=2·7 volumes) of moisture for every part of CO_2 found in the air of a room. More oxygen is absorbed than there is CO_2 given off—thus decreasing the actual volume of air taken in; but, as heat expands air, the expired air increases in volume.

Amount of CO_2 given off per hour (in cubic foot) varies with individuals, their age (size), condition &c. Thus,

By adult Male	at rest	0·72	cub. ft.
	on gentle exertion	0·9	,,
	after hard work	1·8	,,
By adult Female...	of each of the above	1/5	
By Children		0·5	
By a mixed assembly at rest		0·6	

It is more in the case of large men and hard work; and less during sleep.

The extent of CO_2 impurity per 10,000 vol. of air is, if—

4 vols—normal.
50 ,, —found in crowded room.
300 ,, —injurious to man.
1000 ,, —fatal to man.

Effects of inhaling excess CO_2 are:—A feeling of drowsiness, headache, oppression, dizziness, nausea, quickened breathing &c*. The excess of CO_2 in air of inhabited rooms is not, per se, productive of injury immediately; but, its injurious effect is directly proportionate to the increased **temperature** and **humidity** of the atmosphere of the room. The reasons for thinking so, are:—(*a*) Lowering the temperature and humidity of the atmosphere, removes the injurious effects, just as increasing them augments the effects. (*b*) Fifty volumes of CO_2 per 10,000 vols. of air is about the greatest amount of impurity by CO_2 found in the worst crowded rooms ; but even this is only ⅙th of the amount of CO_2 (300 vols.—*see* p. 17) that can appreciably affect the respiration. (*c*) Ozone is normally absent from town atmosphere ; hence, its absence cannot be responsible for the effects. (*d*) The organic putrescible exhalations from air-passages (containing fat, epithelium &c.) and the odoriferous volatile substances given off by human bodies, do not contain anything of the nature of a poison ; but, they are directly proportional to the amount of heat of the atmosphere. Although it is yet a debatable point as to whether the amount of CO_2 or that of organic impurities present in an atmosphere is the real cause of the deleteriousness of that atmosphere, yet, for practical purposes, the measure of the readily-tested **CO_2 is the measure of concentration of other impurities.**

Diseases due to air vitiated by respiration (excluding those due to atmospheric dust) :—(1). **General ill-health**—characterized by rickets in children, and by anæmia, dyspepsia and lassitude in grown people, with a lowered resistance against all acute maladies—in both ages. (2). **Phthisis.**—The germ of this is sprayed into the atmosphere of a room by the coughing of a patient suffering with it, and may then and there be readily inhaled into healthy lungs. Also, the spores of this germ resist drying ; hence, dried sputa containing those spores left on walls or floor by previous phthisical occupants, may be set flying about, by sweeping the room clean and can be readily drawn into the lungs of new occupants. (3). **Acute diseases of air-passages**—such as catarrh, bronchitis, tonsillitis, diphtheria, sore-throat, pneumonia &c. (4). **Parasitic skin diseases** whose sporules and mycelia float on air. (5). **Infection of open wounds** by erysepelas, hospital gangrene &c. ; or, through wounds, by—pyæmia, septicæmia &c. (6). **Infections** whose germs stand drying badly but retain vitality in moist air *e.g.*,—enteric fever, cholera. (7) **Eye diseases**—ophthalmia (purulent or granular).

(B). VITIATION BY COMBUSTION.

Vitiating capacity :—For illumination or fuel, we use one or the other of the following, whose vitiating powers are also noted below (that of an adult man being given at the top for purposes of comparison) :—

Combustibles.	Products (besides CO_2 and H_2O.)	Actual O (c. ft.) consumed.	Amount necessary for 1 hour's consumption.	Yield of CO_2 per hour in cub. ft.	Yield of H_2O per hour in cub. ft.	Cub. ft. of air required per hour.
Adult Man	N	0·94	——	0·6	——	3600
Wood...	CO, H_2SO_3, C		——	——	——	——
Coal (Anthracite) ...	S, H_2SO_3, H_2SO_4 tar.		——	——	——	——
Coal gas purified. 1 cub. ft. ...	SO_2 H_2SO_3		1 cub. ft.	0·52	1·34	1200
Flat flame 4 c. ft. ...	Ditto		4 ,,	2·0	——	10,000
Paraffin Oil	C		62 gr.	0·28	0·22	——
Sperm Candle (Six's) ...	C		120 gr.	0·41	0·41	——
Electric Light (arc) ...	HNO_3		Variable.	Nil	Nil	Nil

Quantity burnt.—*A gas stove* usually burns 5 to 40 cub. ft. of gas; an *Argand gas lamp* (of 30 candle power) burns 8·83 cub. ft. gas; a *flat flame gas lamp* (fish tail or bat's wing variety, each of 16 C. P.) burns 4, 5 or 6 c. ft. gas according as it is No. 4, 5 or 6. Air-tight *electric bulb light* does not in any way vitiate the air. A pound of *paraffin oil* is equal, in polluting effects, to 15 c. ft. coal gas.

Carbon monoxide, the result of incomplete combustion, is generated in greater quantities by closed stoves when over-heated.

Varieties of coal.—*Peat* or *Turf* is a mixture of mud with partially decayed plants and roots, found in marshy areas. *Lignite* or *Brown coal* is an imperfect variety of coal. *Bituminous coal* is softer and burns with a smoky flame: from it coal gas is prepared. *Cannel Coal* burns with a clear yellow flame; *Anthracite coal* furnishes very little or no flame or soot. *Petroleum oil* is the expelled liquid portion of decaying vegetable and animal matter buried deeply under earth.

Paraffin oil.—1℔ oil requires 138 c. ft. air and pollutes as much as 15 c. ft. coal gas. An ordinary oil-lamp requires as much air as a gas jet burning 4 to 5 c. ft. gas per hour. Per weight, paraffin oil is twice as powerful an illuminant as candles.

The standard unit of illumination—(a) in England is—a six *sperm candle* burning 120 grains per hour; (*b*) in France is—the *carcel burner* = 9·3 English Standard candle; (*c*) *Vernon Harcourt's Standard* = 1 English C. P. (candle power).

Comparison of illuminants.—Every illuminant or fuel—(*a*) **takes up from the air** a certain amount of oxygen; and (*b*) **gives up to the air**—CO_2, H_2O and heat; sometimes also H_2SO_3, CO, C and other poisonous and irritating products of combustion. The commonest illuminants are :—

(*a*) **Electric bulb light**—takes nothing of the air and gives nothing to it except heat. **Electric arc light,** however, gives heat and nitric acid to the atmosphere.

(*b*) **Coal Gas light**—It may be used in two ways :—(*i*) Without any burner.—This vitiates by CO_2 as much air as an adult man's respiration does ; but, an ordinary domestic burner burns 4 to 5 c. ft. gas per hour and hence vitiates per hour as much air as 4 or 5 men do. Three burners therefore are equal to 12 to 15 men's respiration, and, hence, to keep the air of rooms healthy, at least 1800 c. ft. of air per hour must be supplied for each cubic foot of gas burnt. Unconsumed coal gas being poisonous, even minute escapes (which mean, escape of $CH_4 + C_2H_2 + C_2H_4 + H + CO + N + CS_2$) are dangerous. (*ii*) With Welsbach incandescent burner (*i.e.*, a Bunsen burner with a chemically treated asbestos mantle over gas jet) or with mantles of oxides of various earths, there is less atmospheric vitiation by CO_2 and less heat.

(*c*) **Candles.**—Compared with coal gas, of equal volume, candles give more impurity to the air. But, as, with candle, one is content with less illumination than in the case of gas, there is less vitiation, if only one candle is burnt. One hundred and fifty cub. ft. of air per hour keeps away the vitiation due to candles. Ordinary coal gas light = 16 candle power.

(*d*) **Acetylene** (C_2H_2) is equal to 240 cp. (candle power) in illuminating effect. It is explosive (even when present at $3^{\circ}/_{o}$) and when it leaks, is injurious to health, but only to a slight extent.

For equal power of illumination, say 16 candle-power,

	Sperm Candle.	Paraffin Oil.	Gas burnt in	
			Flat burner	Argand burner.
Amount burnt	1740 gr.	992 gr.	5·5 cft.	4·8 cft.
O removed	9·63 cft.	6·24 cft.	6·50 ,,	5·75 ,,
H_2O produced	6·56 cft.	3·50 cft.	7·35 ,,	6·40 ,,
CO_2 ,,	6·56 cft.	4·45 cft.	3·50 ,,	2·50 ,,
Air vitiation equal to adult	11·0	7·5	5·0	4·5

As fuels : **Coke** gives less smoke and greater heat ; **Coal** is smoky ; (*c*) **Wood** gives less heat and smoke.

(C) VITIATION BY FERMENTATION AND PUTREFACTION.

Sources.—Places where fermentation or putrefaction on a *large* scale is going on, are :—Hospital wards, sewers, drains, refuse heaps, collections of rotten leaves, cess-pools ; grave-yards, sewage farms, septic tanks ; marshes, fields strewn with carnage ; brick fields, cement works ; tallow, bone-charcoal or manure manufactories.

The poisons given off from such places are chiefly :—(*a*) Carbo-ammoniacal compounds ; (*b*) simple gases—CO_2, H_2S, CO, CS_2, CH_4, N etc. ; (*c*) organic vapours containing ptomaines, leucomaines ; (*d*) suspended particles—dead organic debris, bacteria, moulds, fungi and their spores.

Diseases produced by inhalation of air of such places depend on (*a*) whether *germs* of diseases or (*b*) *chemicals* have been imbibed. Thus, the diseases **due to germs are** :—typhoid, dysentery, cholera, summer diarrhoea ; severe tonsillitis, diphtheria ; pyæmia, septicæmia, erysepelas, lymphangitis, phlebitis, petechial rashes, glandular enlargements, venereal diseases, hospital gangrene ; smallpox, scarlet fever, puerperal fever ; ophthalmia. Those **due to chemicals** (gases) : anæmia, intermittent fever, unconsciousness, rapid death.

Elements of danger : They vary with the source ; thus, in the case of :—(1) **Sewer or untrapped drains** : if these are without much fall and ventilation, then, in proportion to its stagnation, the sewage decomposes and, by the bursting of the bubbles of decomposition, it sprays into the sewer-air innumerable germs ; splashing in untrapped drains also sprays germs into the air. (2) **Cesspools** or **marshes or old closed**

sewers.—The dangers are (*a*) explosions occurring in presence of flames; and (*b*) sudden asphyxia from H_2S inhalation. (3) **Chimneys**—may cause sudden asphyxia from inhalation of CO or H_2SO_3 or carbo-ammoniacal products.

Sewer air vs. Atmospheric Air.—A well-ventilated, water-tight sewer, with good gradient, contains air which contrasts well with atmospheric air and is remarkably pure, so far at least as the number of microbes is concerned. But in sewers where the sewage (*a*) stagnates, or (*b*) splashes, and (*c*) ventilation is defective, the number of germs is very great, oxygen is lessened and CO_2 and H_2S are much increased.

(D) VITIATION BY INDUSTRIES.

Nature of Vitiation.—Various modern industries give rise to (1) flying **particles** of hard, sharp and angular substances which get too firmly lodged in lung-tissues to be expectorated, as, in metalliferous mining, stone and slate-quarrying, cutlery, file, pin, needle or tool-making, pottery or china manufacturing, building, brick laying &c.; (2) fine filamentous particles, as in jute mills, (with all their previous **germ**-contaminations), which, gaining entrance into lungs produce infection; (3) various mineral **dust** raised in factories in sufficient quantities to give rise to metallic poisoning (chronic or acute); and (4) **Noxious fumes**, vapours or emanations.

Dangers to workers in factories—are three in number: (1) Inhalation of particles induces in the **lungs** a state of chronic irritation and predisposition to germ infection. (2) Inhalation of dust induces in the **entire system** a state of poisoning by the metals that enter into the trade-processes. (3) As most of these industries are carried on in close places, where hot steam is constantly necessary, the workers are alternately exposed to sudden **changes** of temperature in going in and out of the factories—the body generally and the lungs particularly being thereby rendered more vulnerable.

Mine-air is rich in CO, CO_2, H_2S, CH_4, moisture and warmth and miners are frequently subjected to sudden alterations of temperature ; yet workers in all coal mines do not suffer to the same extent from lung troubles. (1) Those mines, where coal dust is free from sharp points and corners,—are less liable to cause lung trouble, because these fine particles of carbon are arrested in the *nasal* and *pharyngeal* passages ; when *swallowed*, these particles pass through the intestinal epithelium and through the lymphatic system, via the thoracic duct, into the venous circulation, being ultimately arrested in the capillaries of the lungs, The lungs get rid of them when the bronchical glands are healthy or else ANTHRACOSIS supervenes. (2) Where there is a large proportion of stony particles in the coal, lung diseases develop. Miners also suffer from NYSTAGMUS where the mines are feebly illuminated.

Preventive remedies :—**Raw materials**—should be received, stored and conveyed from place to place in covered, non-absorbing receptacles. If this does not ensure complete prevention of noxious fumes, vapours or emanations, deodorizers and antiseptics must be provided. **Premises** for storing or working such stuffs should have non-absorbing floors and walls, efficient drains, efficient water-supply, ample light and ventilation and be lime washed twice a year. All sullage should be cooled before being discharged into drains ; all fumes should have ample outlets. To protect **workpeople** directly, (1) ensure cleanliness of the place and of the workers ; (2) have hood above, and perforated metallic plates under, the benches—both provided with exhaust fans to suck away the dust ; and (3) provide artisans with respirators.

(E). VITIATION BY HOUSEHOLD DUST.

Composition of Dust : Soot, mineral particles (common salt, rust, silica), fibres of cotton, pulverised straw, epithelial or epidermic debris, dried foecal matter of animals, dried street refuse, dried sputa with spores of fungi or of bacteria anchored to them. Most of these are *putrescent* and germ-laden and therefore harmful.

Sources : (1) From *outside* the house—being blown into our rooms from streets. In tropical climates, during the hot weather, regular dust-storms are frequent. But, more often, dust is imported into rooms by the one universal mop or broom that sweeps up the drives, the sanitary conveniences and perhaps the entrance hall. (2) *Inside* the premises,—from wear and tear of domestic life.

Receptacles of dust in our household : All floors, corners, crevices, projections, hangings, fittings, furniture.

Means for prevention of dust accumulation :—

Floor—must be smooth—without any pattern being worked into it and glazed,—either marbled or cemented or accurately wood-paved and polished. In *kutcha* houses, floor should be regularly mud-lipped and kept free from cracks. *Carpets* should be abolished ; *linoleum* and *oilcloth* should be avoided ; *matting* can be allowed, if frequently removed and beaten in the open air. It is a good practice, in Indian household, to moisten the dusty floor before sweeping it with the broom ; and all places should be finally wiped with a damp cloth. It is unsafe to have a universal broom or mop.

Walls—should be plastered smooth and free from sharp corners, projections and cornices. (*a*) If required, *distemper colouring* can be ordered but *painting* should be avoided, if it cannot be free from lead. (*b*) If *papering* is desired, use varnished, smooth (and not flock) papers free from arsenic.

Sash Windows and **Doors**—should be kept shut, to keep out regular dust storms, provided a fan is kept going regularly and ventilation can be carried through deep verandah ; otherwise, moistened Khus Khus or other tatties will keep out dust at noon.

Curtains, Canopies, Draperies—can be of light muslin but never heavy and they should frequently be washed.

Furniture—should be light, so as to be easily moved about and never placed so as to render portions of wall or floor inaccessible to the broom.

CHAPTER III.

VENTILATION.

Definition.—Ventilation is the *dilution* or *removal* (by a supply of pure air) of all the impurities that can collect in the air of areas under examination. Ventilation is **external** when it refers to purification of air around our buildings ; and **internal**, with reference to air inside our buildings or apartment. **Natural** ventilation, which does not involve any troublesome or expensive apparatus, has reference to the action of rain, wind, sun and vegetation. [*Plants* take up CO_2, and give oxygen to air ; *rain* removes solid and most of the other organic impurities ; the *sun* is a germicide and by heating the atmosphere secures movement of air] **Artificial** ventilation (which requires such apparatus) refers to the various means we take to secure purification of air of confined spaces.

(A.) EXTERNAL VENTILATION.

Town-ventilation is secured by—

I. **Street-laying-out** : Thickly populated or densely built areas should be opened up by long and wide streets.

Every street should (*a*) have a minimum *width* of 24 feet, if not used as a carriage road, or of 34 ft., if used as such; (*b*) be open at least at one *end*; (*c*) be as *straight* as possible; and (*d*) be regularly *watered* and *oiled* to keep down dust.

II. **Building Regulations**:—(*a*) Buildings should never be constructed *back to back*. (*b*) The *height* of no building should exceed an imaginary line drawn at an angle of 63·5° from the farthest end of opposite side road-level. [Chimneys, dormers, gables, turrets or architectural ornaments are excepted]. (*c*) Every building must provide for a minimum of one-third of its total area (or 150 sq. ft. in its rear) entirely open to the sky, the open space extending throughout the entire width to a depth of at least 10 ft. from the building, and increasing with the height of the house upto 35 ft.

III. Prevention of throwing **refuse** into streets at all hours and in all stages of decomposition and by controlling **offensive trades.**

IV. Providing **open spaces** as lungs of the town—*e.g.*, Parks, gardens, promenades &c.

V. **Smoke Prevention**—The use of COAL as fuel is responsible for (*a*) *smoke* that hangs over towns, *soot*, *fog* and *mist*. The reason is that owing to incomplete combustion of coal, fine particles of it float in the air. Coal is used both by householders and factory owners; hence, both these parties contribute to the production of smoke. In India, WOOD is very extensively used as fuel and that also is responsible for some smoke.

To abate smoke nuisance, the following measures are recommended:—IN THE CASE OF PRIVATE HOUSES:—Use coal gas *stoves* or *electricity* as fuel. Probably this is not very much more expensive in the long run. Use *coke* rather than coal. IN THE CASE OF FACTORIES,—it is permissible to allow emission of dense smoke for a short period at the hour of rekindling fires; but prosecute, if smoke is emitted for a period exceeding 1 to 10 minutes in an hour. To abate smoke,—(*a*) Use *anthracite* coal and coal dust or smokeless *coke*. (*b*) Use *gas* furnace, such as Siemens'. (3) Have *frequent, light firings*; this may be effected by (*a*) sprinklers and (*b*) mechanical stokers. (4) Secure admittance, into the furnace, of the *necessary air*, to provide complete combustion, by one of these means:—(*a*) wash the smoke by water-spray or steam, or, by fans, force the smoke to traverse the fire again; (*b*) have chimneys of adequate height and capacity; (*c*) see that fireplaces and boilers are in size proportionate; (*d*) handworked grids or circulars in the doors; (*e*) automatically working louvres or panels in the furnace door.

Mines—are ventilated on the *principle* of heating a column of air in an extraction-shaft—a fire being burnt at the bottom of an *upcast* shaft (often an exhaust rotary fan working at the top of this shaft); the *downcast* shaft lets in pure air which has to travel all the galleries and cannot make a short circuit. *Quantity*: At least 6000 cub. ft. of air per hour should be supplied for every man below; and, if more air, containing 17.5 (instead of 21%) of oxygen is liberally supplied, there will be little risk of explosions from CH_4 or asphyxiation from CO_2 (which must not be more than 0.25%) or from H_2S.

Ships are ventilated through pipes heated by their boilers and funnels, aided by proper cowls.

Tunnels—like mines—may be ventilated by (*a*) *shafts*—single or double, (*b*) *heat* from a furnace or open fire at the foot of upcast shaft, (*c*) *steam jets*—playing into vertical pipes fitted to a frame on the top of the upcast shaft, (*d*) *pumps*—which expel air simultaneously with sucking in water and vice versa (*e*) *Fans*.

Large Buildings and Halls—are ventilated through (1) long shafts passing from outside the building into a storage chamber,

(2) Propelling revolving *fans*, (3) extraction by *heat*, *steam jet* or fans. (4) 'Sunlights' *burners* at ceilings (5) *steam jets* forced through a chimney flue, (6) air propelling fans.

(B) VENTILATION OF INHABITED ROOMS.

Introduction.—Oxygen is indispensable and on the relative per centage of it depends our metabolic activity and therefore, our health. Ventilation seeks the *access of oxygen* and *removal of* CO_2 and organic and other impurities. But however important oxygen may be to us, beyond a certain percent., if it is present in air, even oxygen too becomes injurious ; hence, *Nitrogen* acts as a diluent of oxygen and is a necessity.

In the **Tropics**, *in the plains*, in summer, breezes are a necessity as much for ventilation as for comfort ; in winter, the cold is never so rigorous as to necessitate the shutting up of window sashes, much less a warming fire. *In the hills*, in the tropics, in summer, breezes may not be always pleasant ; while winter requires a *warm fire* in addition to *closed window-sashes*. The means of artificial ventilation described below apply specially to these last conditions and to **cold countries**. Ventilation in the tropical plains is, as a rule, very efficient, if only windows and doors *opposite to each other* are kept open. Ventilation in a *Hut* is abundant through its porous walls, open spaces left near the ceiling all around, windows, leaky doors &c.

So, ventilation has special reference to *Cold* climates, where (*a*) sashes have to be kept more or less shut, (*b*) a warming fire must burn inside the room and (*c*) air has to enter without creating draught. Before we can understand the details, we must learn our hygienic requirements.

A standard of purity of the atmosphere—is necessary at the outset. We know that the amount of CO_2 in an atmosphere is a fair index of its vitiation. The **initial** or **normal impurity** (*i. e.*, 0·4 parts CO_2 per 1000 parts of air) has reference only to *out-of-doors* air; that laid down as the permissible limit of **standard** or **respiratory impurity** in the air of *rooms* (the doors and windows of which are *shut*) is—0·2 per 1000, *over and above* the 0·4 found in normal air—or, a **total** or **maximum impurity** of 0·6 parts of CO_2 per 1000 volumes. Now, a man expires 102,000 cub. in. of air in an hour. This means, a vitiation of 1% (volume) of CO_2 per hour. At this rate, in twenty minutes an average adult vitiates his alloted 1000 cub. ft. of confined air. But air containing 1% CO_2 is unwholesome; hence, it must be diluted, until the total CO_2 does not exceed 0·6 parts per 1000. This is done by the admission of 2000 cub. ft. of pure air per hour—a man thus requiring 3000 c. ft. of air. For, in 20 × 3 minutes—he gives, $(0{\cdot}4 \times 3) + (0{\cdot}2 \times 3) = 1{\cdot}8$ parts CO_2 to 3000 parts of air (or 0·6 in 1000 c. ft.).

Supply of fresh air needed.—On the basis of this calculation, *physiologically*, a male adult at rest, in a closed room, requires 3000, or more correctly 3,600 cub. ft. of fresh air per hour so as not to vitiate the atmosphere beyond 0·2 per 1000, (*i. e.*, 0·4 + 0·2). The following table shows the minimum supply per hour physiologically necessary :— (in c. ft.)

Male (adult) at rest	3600
doing gentle work ...	4750
,, hard ,, ...	9800
ill at home	3750
in ordinary hospital ...	4000
in infectious or lying-in hospitals	6000
Female (adult) at rest	3000
Average of a *mixed* community ...	3000
Child at rest at home	2000
Horse or **cow**	10,000 to 20,000
Gas (Coal) (5 c. ft. per hour) ...	9000

A domestic animal, if large, requires on an average, 20 to 25 cub. ft. of air per hour for every pound of its body weight. Wild and smaller animals need more air in proportion to their body weight, because of their rapid tissue change.

But, we have to remember the inconveniences of (*a*) cold draughts, (*b*) of excessive radiation of body heat to cold objects around, and (*c*) the elaborate and expensive mechanism involved in keeping up this *physiological* standard of purity, *i.e.*, 3600 cft. of air per man per hour; hence, *in practice*, we supply per hour to—

Hospitals (ordinary)	... ...	2000 to 2400 c. ft.
,, (epidemic)	... ...	5000 to 6000 ,,
Workshops (ordinary)	... ...	2000 to 6000 ,,
,, unhealthy	... ...	3500 to 6000 ,,
Prisons ...	... ...	1700 to 2400 ,,
Theatres ...	... ...	1400 to 1700 ,,
Meeting Halls ...	... ...	1000 to 2000 ,,
School (per child)	... ...	400 to 500 ,,
,, (per adult)	... ...	800 to 1000 ,,

Cubic space.—As it is not possible to remove *at once* each expiratory impurity without special mechanism and much draught, a minimum *space* per head must be provided to ensure a *reserved* supply of fresh air, to dilute the fast-appearing respiratory impurities and to allow *slow* inrush of fresh air from outside. The space to be allotted depends on whether we consider *dwelling* rooms that are more or less continually occupied or *working* rooms, only temporarily occupied by a large number of individuals ;—in the latter case, a greater amount of fouling of air has to be permitted. **Air space** means the space filled with air available for respiration. This is, in cubic feet, roughly equal to a person's body weight in stones multiplied by four. **Cubic space** is the minimum of open area inside a room that should be ordinarily allotted to *each* individual, when his air is kept well *ventilated without causing uncomfortable draughts.* Cubic Space, thus, comprises height, length and breadth; the two latter, divided by the number of occupants, constitute **Floor or Superficial space**. Floor space should never be in area less than 1/12th of the cubic space. The **object** of *cubic* space is to provide ventilation, without creating unpleasant draught; that of *floor* space is, to prevent contact of infection and to take into consideration the slow diffusion of a heavy gas like CO_2 as a part of the ventilating process. Whenever the height of a room exceeds twelve feet, the excess in height becomes a source of fouling the room-atmosphere, by cooling the heated foul air and allowing it to remix with the air below, specially so, when gas is burnt. Excessive height of a room, therefore, is of little use to its occupants, unless means exist for removing the heated air from the upper part; hence, a lofty room is not necessarily airy. Greater attention must, therefore, be paid to the floor space. Because, in a small room (with less air space) air has to be frequently changed; while a large room (with large air space) can be more slowly ventilated without the production of draughts; but, a large room must, on no account, be regarded as a store-house of fresh air, nor can a small room, closed as it is in cold countries, be properly ventilated even by frequent renewals of air, owing to the fact that the incoming draught is not sufficiently broken up, diffused or mixed with the heavy respiratory impurities before it rushes out of the room.

Amount of cubic space necessary :—If the air of a place is renewed three times an hour (more than which, in cold countries, creates unpleasant draught), 350 cub. ft. of space for an adult is sufficient; but, in the absence of renewal, 350 c. ft. of air suffice barely twenty minutes. On this principle, in ventilated rooms, the following *minimum* cubic space is allowed in the United Kingdom:—

	Floor Space in sq. ft. per bed.	Cubic space in c. ft. per bed.
Adult at rest	...	1000
at hard work	...	3600
Child (12 to 18 years)	...	700 to 900
Barrack rooms continually occupied	50—80	600
Lodging houses	42	300—400
Factories and Workshops (ordinary hours)	...	250
overtime	...	40e
Hospitals, General	90—140	1200—1600
Maternity	100—140	1200—2000
Infectious	140—200	2000
Poor houses and workhouses.		
Sick	72	850
Lying-in women	100	1200
Infirm persons able to leave dormitory during day	42	500
Healthy person	42	300
Prison cells	80—120	600
Schools: Day Schools	8—15	80
Dormitories	50—60	400
Canal Boat		60
A horse or cow	...	1600
A gas burner	...	2250
A paraffin lamp	...	3000

It is important always to remember that the cubic space of a room is less important than the capacity for frequent interchange of air (without creation of unpleasant draught).

Agencies of Natural Ventilation (besides sunshine, action of rain and of plants) :—The impurities of the air of a room are *solid* (dust, soot, organic matter &c.) or *gaseous* (CO_2, H_2O &c.) Of these, the solids tend to settle down on the floor, and can be removed only by strong winds or by sweeping; our concern is with the gases chiefly* These gaseous impurities are diluted or removed chiefly by three agencies :—*(a)* **Diffusion :** Gaseous impurities diffuse into pure air, till a homogeneity is established; this occurs at a rate inversely as the square-root of its density. Thus continually is pure air coming into, and impure air going out of, every room through its chinks and openings, bricks, porous partitions, mud wall etc. *(b)* **Differences of temperature** between places—which cause active movements of the air. In a room 8 ft. × 4 ft. × 6 ft., a man burning a candle would raise the temperature of its air 60° to 70°F. In winter, the outside temperature is cooler; while in summer, often the room temperature is cooler. It has been found that the greater the difference between outside and inside air temperatures, the better is the ventilation and vice versa. Heated air tends to rise from, and cooled air tends to fall to, the ground. *(c)* **Winds**—are uncertain of movements, therefore, difficult of regulation. They act as ventilating agents in two ways :— (i) By *Perflation—i.e*, by driving the impure air before them through two openings opposite to each other and situated at the same level. Hence, if opposite doors and windows are not open or impediments are placed before the perflating wind, ventilation is not efficient. Wind may even obstruct the egress of vitiated air, if it blows into the mouth of its exit- shaft ; (ii) By *Aspiration*—drawing the impure air along with the wind, thereby causing vacuum on each side of its track, towards which air from around flows, at right angles to the track of the aspirating air.

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* We do not minimise the devitalizing influence, on fresh air, of long accumulated *organic* impurities that certainly collect in bed rooms that are not properly ventilated. Furniture, wearing apparel and other articles that can become receptacles for organic emanations from the inmates of a bed room, should not be kept there; nor should a bed be "made" till sometime after using. A bedroom should be freely flushed with air and left unoccupied in the day-time and even in the night-time, occasionally.

Dynamics of Ventilation are two : (*a*) If a difference of temperature is produced between airs in and outside of a room, then a "head" (*i.e.* difference of pressure per unit) of air is created : in consequence, the heated air rises up and cold air rushes in its place ; (*b*) so long as this head is maintained, air-movement will be continuous. That then is what keeps up ventilation.

Regarding movements of air, it should be noted that air moving at the rate of two miles an hour, is hardly perceptible ; if such air is allowed to pass through a space 20 ft. wide, it changes the air of the space so much as 528 times an hour ; but, change of air more than three times an hour causes draught. Hence, if we know the *velocity* of the wind, we can regulate the **cubical amount of air that should enter a room,** by regulating the *area* of the inlet,—remembering to take into consideration, in each case, (*a*) the precise number of occupants, (*b*) the amount of artificial lighting and (*c*) other special cause of air-vitiation.

SYSTEMS OF VENTILATION.

Systems of Ventilation are two in number, *viz.*, (1) *Natural*, (2) *Artificial* or *mechanical* system ; This latter comprises—(*a*) *Plenum* and *Vacuum* systems. The swinging *punkha* and the electric *fan* combine the advantages of both these systems. It is very doubtful if a swinging *punkha* or electric fan can suck in sufficient air from outside to purify a vitiated room-atmosphere—specially so, when most needed for the purpose, *viz.*, in very hot weather, when the air inside and outside a room is practically of uniform temperature and therefore scarcely moving. (*b*) *Balance* system (*i. e*, balance or combination between propulsion and extraction) :—Pure air is forced into rooms by propelling-fans at the walls, 7 ft. above floor-level and impure air is extracted by exhaust-fans at the ceiling. (*c*) *Verity's system.*—A number of fine jets of water is used to set air in motion. (*d*) System of *Ozonization of air* (upto 10 parts of ozone per million parts of air).—This may destroy solid organic impurities and mask the odour of volatile organic matters, but has no microbicidal action, unless in the proportion of 3000 volumes per million; this is therefore little used.

As almost all systems of ventilation partake more or less of artificial and mechanical characters, this latter is the better classification. To secure ventilation, we must have properly constructed (*a*) Inlets for pure air, and (*b*) Outlets for impure air. Where a chimney is in use, it acts as outlet ; but if it is insufficient, more outlets should be provided.

(A.) *VACUUM, ASPIRATION OR EXTRACTION SYSTEM.*

This seeks to introduce a current of fresh air into a room, to replace the vitiated and *warmed* air inside that room going out by the outlets provided.

Ventilation by the aspiration method is secured by—

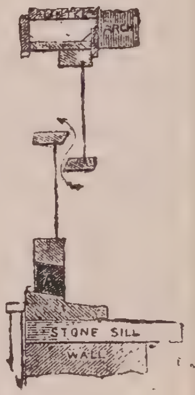
(1.) Ordinary *open fire with flue*—which is, in addition, a heating arrangement. [In a hospital ward of 10,600 c. ft., accomodating 5 infectious cases, a cylindrical $1\frac{1}{2}$ sq. ft. flue will draw 53,000 c.ft. air per hour]. (2.) Fire-places that are *Ventilating Grates* (*e.g.*, Galton or Manchester grates).—They will maintain a circulation of air of rooms devoid of other outlets or inlets. (3.) Ventilating *Shafts.*—Their action is improved by creating fires near their mouths. (4.) Well regulated *system of inlets and outlets.*—Note that cowls have no action as ventilators.

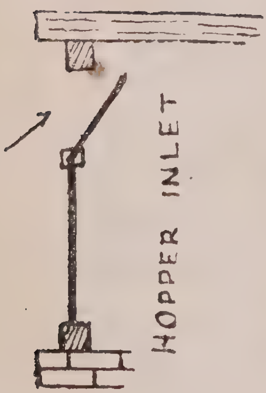
The open fire and grates have been described in the chapter on warming and the last two are detailed below :—

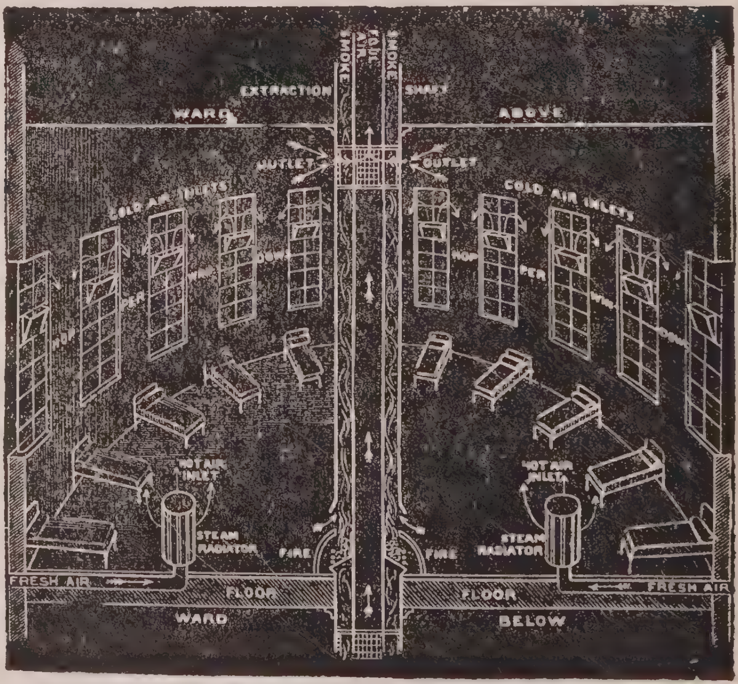
I. **Inlets :** Their *object* is to let in pure air. (*a*) Their *direction* and *situation*—should never be too near the outlet-tubes and always away from polluted air. If they are to admit cold air (60° F), then they should be at least 9 ft. from the ground and directed upwards towards the ceiling, so as not to impinge on occupants and thereby chill them ; if they are to admit warmed air, then they should be placed near but not at the floor (so as not to raise dust) and be directed downwards. (*b*) *Size*—should be capable of regulation and be $1\frac{1}{2}$ times greater than the size of the outlet. A number of small divided openings is not collectively equal in ventilating power to one large opening having the same area. Roughly speaking, 24 to 48 sq. in. inlets are necessary to each occupant. (*c*) *Shape* and *Length.*—A cone-shaped opening, with the larger end inwards, is a better ventilator than an opening of uniform calibre. The shorter the inlet, the greater is a steady current ensured. (*d*) They should be capable of allowing *constant* (and not intermittent) current of air-entry, as, otherwise, organic impurities inside the room will not be removed. (*c*) They should as much as possible break up the incoming current of air.

Types of Inlets

1. Through the window :—Windows in cold countries are usually made of glass-panes rather than of wooden panels : (*a*) *Hinckes-Bird's* modification of this double-sash,—consists in raising the lower sash by a block of wood, so as to create a corresponding space between the meeting rails in the middle of the window ; it secures passage of air *between* the glass panes right towards the ceiling. (*b*) Construction of panes on deep *beaded sill* so as to admit air between the sashes, without raising the lower sash. (*c*) Boring *holes* in a perpendicular direction in the bottom of the rail of the upper sash,

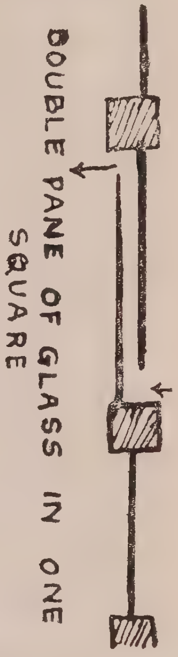




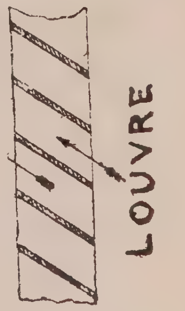


A circular ward in the Liverpool Royal Infirmary.

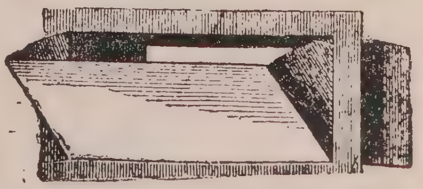
or putting a perforated zinc gauge across the removed upper part of the top sash. (*d*) Glazed frame of "*hopper inlets*"—may be affixed to the lower sill or above the sash-frame of a window. They are made to fall inward; they do not cause draughts, do not obstruct light and are useful where radiators are fixed on an external wall under a window. (*e*) Modification into *double pane of glass in one square*—open at the bottom outside and at the top, into room where air enters. (*f*) A Sherringham-*Valve-like arrangement of one of the squares* of glass—whereby it is let fall inwards upon its lower border, governed by side-checks (similar to Steven's Drawer). (*g*) *Louvred* Inlet—where strips of glass are fixed on a frame—like venetian blinds,—parallel to each other and at an upward incline; these can be shut or opened at will.



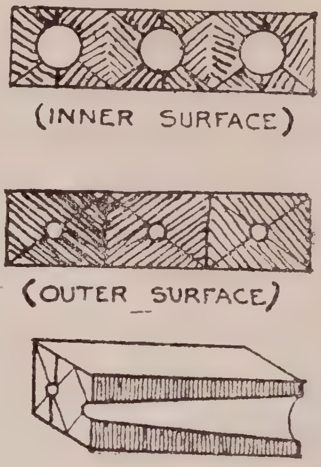
(*h*) *Boyle's or Cooper's Ventilators* (for windows that do not open) consist of a series of apertures arranged in a circle, which is moveable on a pivot. The size of these apertures can be regulated by a revolving disc of similar design or by wire gauge or muslin in front of the ventilator.



2. THROUGH THE WALLS: (*a*) *Sherringham Valve*—is an iron box fixed high up on the inner wall, but not too near the ceiling. Its internal opening has an area of 27 inches. It can be made to close or open by means of a balanced weight. Air from outside entering through perforated bricks is directed towards the ceiling by it.

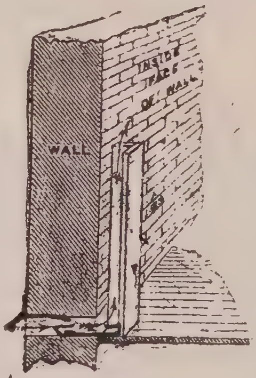


(*b*) *Ellison's Perforated Bricks*—The perforations are trumpet-shaped, the wider area of the funnel being directed into the room. (*c*) *Louvres* may be fixed to walls too. (*d*) Simple *iron grating* or *perforated zinc sheet* may be put into a deficiency in the wall.

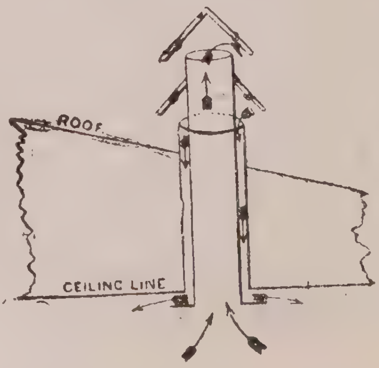


Perforated Brick

3. At the Floor :—*Tobin's Tube.*—This comprises—a horizontal tube, 6″ to 12″ diameter, guarded at its entranceby a perforated plate which enters the outside-wall at floor-level. This tube leads into—a vertical tube, upto a height of 4 to 6 ft. This gets uncleanly easily, unless regularly looked after. Air passing through it may be filtered of dust by covering the tube with muslin or by making the air impinge upon a tray of water.



4. Through ceiling : (*a*) *Mc Kinnell's Ventilator*—is a combination of inlet and outlet—the outer jacket of tubing being for inlet and inner jacket, the outlet-shaft. (*b*) *Chimneys* should not on any account act as inlets, nor be overlooked by neighbouring houses ; they should be protected by cowls.

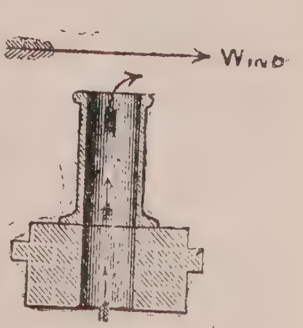


II. **Outlets** : These are of greater importance than inlets, for, air tends to leave a room by definite openings ; whereas, if egress of air is free, ingress will somehow take place through all possible crevices and cracks. Outlets should (*a*) be *situated* near the ceiling immediately over vitiated air ; (*b*) be *enclosed* within walls, so as to prevent cooling of outgoing air ; (*c*) have *smooth* inside walls and if possible, *be single*, to prevent contrary action between each other and to reduce friction to a minimum ; *(d)* have *cowls* or be raised higher than the highest building ; (*e*) their two ends should be *narrow*, so as to produce a rapid current at the entrance and exit ; *(f)* be capable of being *kept clean* ; (*g*) be of same *size* as or slightly larger than inlet (24 sq. in., both, of inlet and of outlet per head of occupant)—being proportionate to the size of the room ; but no single outlet should be more than 144 sq. in. ; and (*h*) should have their *extractive maintained* by heat or exhaust fan or else they may act as inlets,

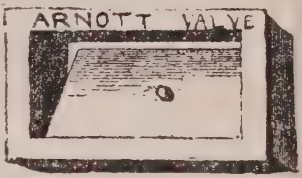
Types of Outlets.

I. AT THE CEILING :

1 *Chimney-flue*—is a good outlet, provided, it is protected by a cowl, and its two ends are narrowed. It acts so, because (*a*) air inside a room being hot, rises towards the ceiling ; and (*b*) wind blowing over chimney-top, helps to aspirate the inside air. But the *defects of a chimney are*— that it allows smoky air to get into the room and that it does not aspirate so efficiently the air near the floor. To obviate these, the following modifications are suggested. (*a*) *Establishing a separate small flue*— along side of or surrounding the chimney and communicating with the rooms on each floor :



the heat of the chimney heats the air in this flue and thereby enables this flue to aspirate air from each room in succession. Similar purpose is served by a room opening at the ceiling into an air-tight zinc chamber placed between the ceiling of this room and the floor of the room above—the box being connected through Boyle's valve to the chimney-flue. (*b*) *Making openings into the chimney-flue, through the wall*, at a point higher than the fire-place. This is done through—(*i*) *Neil Arnott's Valve*—which is a light-metal valve, placed inside an iron-box, capable of swinging towards the chimney-flue but not towards the room; or (*ii*) *Boyle's Valve*—which is a grated iron- frame from which are suspended valves of mica, which swing in the direction of the chimney only. [Both these valves cause clicking sound and smoke during high wind.]



2. *Sky or Sun-light openings*—at the ceiling—useful for large rooms; but they cause draught.

3. *Mc Kinnel's Ventilator*—is an opening at the ceiling through two concentric tubes, the outer of which acts as inlet shaft and the inner as outlet shaft. This, like the sun-light, does not require to be associated with a chimney or a burner and is suitable for large rooms which have no other apartments over them.

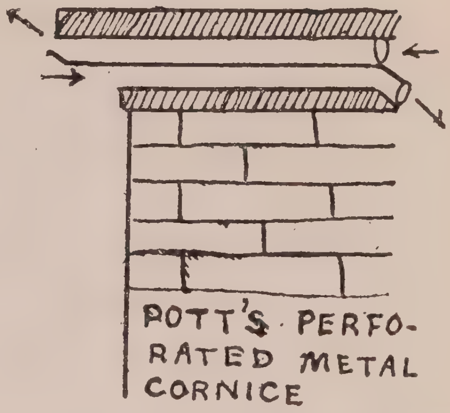
4. *Boyle's Air Pump Ventilator*—which by an ingenious arrangement of metallic segments creates an extracting action on the vitiated atmosphere of room and helps its expulsion.

5. *Gas burner Ventilator* (Benham)—Also called Sun-light or ventilating globe-light burner—It has either a Mc Kinnel's ventilator or simple extraction-shaft placed over it. As the combustion of 1 cub ft. coal gas causes the discharge of 1000 c.ft. of air, its action is very efficient.

II. THROUGH THE WALLS :

1. *Pott's Ventilating Cornice*—which is made of a double channel of perforted metal : pure air enters through the lower half, which communicates with outside air, the upper half opening into the chimney.

2. By *perforated inlet tubes*—being laid along the cornice of three sides of a room, a similarly perforated outlet tube being laid on the fourth side.



3. By *transverse ventilating boxes or tubes*—being placed at regular intervals, close to the ceiling.

Kitchens require very efficient ventilation. They should be situated either detached from the main building or on the top floor. Wherever situated, they should have chimneys to convey out the smoke and "clerestory windows" near the roof to admit light and air.

The **Pantry,** the **Servants' quarters,** the **stairs** should also be amply ventilated.

(*B.*) *PLENUM OR PROPULSION SYSTEM.*

Where required.—This system is suitable for *large* buildings where a *large* number of people is collected for *limited* periods (∴ cubic space per head is lowered) and where the doors and windows are at the same time kept *shut,*—*e.g.*, in tunnels, factories, public places, &c.

It is also used in hospitals and schools where the cubic space per head is small (although doors and windows may be open).

Sine-qua-non.—For the successful working of this system the following are necessary :—

1. Good *walls* and closed *windows*—*i.e.*, absence of leakage.
2. *Inlets*—must be louvred or otherwise protected, and have screens for washing and filtering the incoming air ; these must be on the same side as outlets.
3. Series of *pipes*—arranged in sections or groups and heated by steam or hot air.
4. Rotary *fan* (worked by any means).
5. *Air ducts* :—main and branch ones being horizontal ; sub-branch ducts, vertical ; there must also be doors and heating coils and openings near ceilings.
6. Constant attention of competent engineer.

Its **disadvantages** are : (*a*) expensiveness ; (*b*) necessity for laying down the arrangement before a building is completed ; (*c*) want of freshness in the air introduced, ∴ feeling of lassitude Its **advantages** are : (*a*) it is constant and certain in action ; (*b*) it is easily manageable ; (*c*) it enables the in-going air to be warmed, cooled, washed or filtered ; (*d*) the amount, temperature and humidity of air can be regulated to a nicety.

How worked :—On a purely plenum system, air is forced along pipes ; but in practice, it is customary to associate with it the other mechanical means (aspiration &c.) This combination is designated the *artificial* system and each part is worked as follows :—

1. Mechanical ventilation—by aspiration of floating particles. It is specially useful in factories, where fibres and dust fly about.—Their removal is secured by—

(*a*) *Steam jet*—in factories where superfluous steam is available. A jet is passed up a chimney-flue to which (below the point of entry of steam jet) are connected pipes leading from various rooms. One volume of steam aspirates after it 217 volumes of air laden with floating impurities.

(*b*) *Suction-action Fan* or *Archimedean Screw*—fixed to a chimney-flue. From there it acts by aspiration.

(*c*) *Heated extraction shaft.*—The shaft may be heated throughout the greater part of its length either by (i) a spiral of hot water pipes coming from a boiler, or (ii) by fire from the hearth or (iii) by gas burners below the shafts. [In iron-clads and steam-ships, the furnaces are utilized to this end]. The objections to this method are: (i) that the draught created is irregular, as it is not possible to maintain a constant temperature; (ii) that the draught created diminishes in intensity (∴ in utility) the farthest it is from the shaft, and (iii) that air from w. c. may be sucked into rooms.

2. Ventilation by Propulsion (Plenum proper).

(*a*) *Air Propeller* (Blackman) or *Air Blower* (Sturtevant) —worked by gas or steam engine or by water or electricity. The first of these can be used both for aspiration and propulsion.

(*b*) Gasoter *Pump* } Seen in collieries.
(*c*) *Bellows*—of various sorts }

EXAMINATION OF AIR.

I. Note **Temperature**—with the help of reliable *thermometer* placed in shade. Rutherford's or better still, *Six's Thermometograph* can be used to ascertain the maximum and minimum temperatures. [No room-temperature should be below 60°F]

II. Determine **Pressure** by hanging a good *barometer* perpendicularly at a place where the temperature is moderate and uniform.

III. Determine the **movements** of air by observing clouds or *weather cocks*—to determine direction of flow ; and *anemometers* to determine strength. For purposes of hygiene, the *compass* card shows these points : North, North-North-west, North-west, West-north-west ; West, West-south-west, South-west, South-south-west ; South, South-south-east, South-east, East-south-east, East, East-North-east, North-east, North-north-east. And winds are thus classified :

Name	*Speed in metres per second*	*Miles an hour*
Calm (smoke rises perpendicularly)	0· to 0·5	3
Slight (moves light leaves)	0·5 to 4·0	13
Moderate (moves leaves and small twigs)	4 to 7	23
Fresh (moves larger twigs)	7 to 11	48
Strong (opposes walking in the open)	11 to 17	65
Storm (uproots small trees)	17 to 28	75
Hurricane (uproots large trees)	28 to 40	90

IV. "Air which at the prevailing temperature is not fully saturated with watery vapour (**moisture**) becomes, if successively cooled, saturated by the water present and if refrigerated down to dew point, deposits liquid water. Hence determine dew point by *hygrometer*. [Humidity is best between 72 and 77%].

V. **Carbonic Acid** is determined by Pettenkofer's bottle.

VI. Ascertain the Purity of atmosphere—in other words, the state of **Ventilation** of a room. This is done as follow :—

1. Ascertain if the room is to be used as a *working* place (factory, school &c.) or a *dwelling* place.

2. Determine the amount of *gross cubic space* or capacity of the room.

3. Then find out the *available* cubic space per head, by deducting from the gross space—(*a*) dimensions of bulky furniture, (*b*) 3 cub. ft., as the space occupied by each individual or (*c*) 10 cub. ft. for each bed and occupant, (*d*) for each kerosene oil lamp, about seven adults' air-vitiating capacity.

4. Determine the *area of outlet* provision per head. The area of outlet gives a more accurate idea of the total area of inlet, because air can enter by thousand crevices, leaving only by well-defined outlets. [Inlets and outlets are determined by observing the direction taken by smoke or velvet, cotton or small balloons]. *The amount of air leaving a room per second* is determined by multiplying velocity of wind per second by sectional area of the opening.

5. Determine the *velocity of wind.*

6. Then divide the amount of air leaving in an hour by the available cubic space and see if it is *sufficient* or otherwise.

7. Determine the *cubic space* per head by dividing the available cubic space by the number of persons occupying; and the *floor space* by dividing the total floor space by the number of occupants.

VOLUMETRIC DETERMINATIONS.

1. **Carbonic Acid**: [Organic impurities are roughly proportionate to the amount of CO_2] **Collect** the air of the room at suitable period (between mid-night and early morning hours, in case of sleeping apartments), in clean *receptacles* (of known *capacity*) full of water, the water being allowed to run out fully and the receptacle stopped well with rubber-stopper. For **Estimation**, *vide* Appendix. [In a well ventilated room, *respired* CO_2 *should not exceed 1.0 part per 1000 vol. of air*].

2. **Suspended Matters.**—These are *collected* by sucking air into sterile glass surfaces previously moistened with water or glycerine and then examining the glasses microscopically. [*Pouchet's aeroscope*—is an exhausted receiver with a fine aperture].

3. **Microorganisms** - are slowly aspirated into Hesse's tube, the interior of which (previously sterilized) is coated with nutrient gelatine, and after cultivation there, they are examined miscroscopically. [*Moulds and fungi are more abundant in ordinary air and bacteria are more plentiful in respired air or air mixed with effluvia.*]

CHAPTER IV.

(A) WARMING.

Necessity—In the tropics questions of warming rooms and houses arise only in the hill stations in winter. In European countries, on the other hand, this is an every-day necessity ; for, in cold countries, doors and windows are kept shut and at the same time, it is necessary to keep down the CO_2 to 6 vols. per 1000 vols. of air. To do the latter, at least 3000 c. ft. of air per hour per man must be introduced into the room : this may lead to creation of draught ; and draught is painful at all times, specially, if the solid objects in the room are cold. Hence, the necessity of combining warming with ventilation in cold countries.

During cold, heating our houses and apartments is *necessary* to prevent rapid combustion (∴ waste) of our tissues, just as clothing is. And, it is necessary rather that a *uniform*, albeit comparatively low, temperature be maintained inside rooms than that there should be sudden variations in the temperature. The temperature best suited for rooms occupied by—

(*a*) Healthy adults—is 50° to 60°F
(*b*) Old men, Delicate children—65°F
(*c*) Convalescents—65°F
(*d*) Hospitals and sick rooms—60°F
(*e*) Small Pox and Fever wards – 50°F

For heating rooms, the following physical means are available :—

1. **Radiation** *i.e*, the passage of heat on all sides and in equal quantity, through space, to any solid body ; the body impinged upon is heated, and the medium or space is unaffected by heat. *Its disadvantages :* (*a*) As the intensity of radiant heat is inversely as the square of the distance of the heated object from the source of heat, for long rooms or large assemblies, a single source is inadequate, while multiple sources render their vicinity excessively hot. (*b*) It is costly. *Its advantages* : (*a*) It heats the body, without heating the air ; (*b*) there is no chance of impure air being forced into the room.

2. **Conduction** is the passage of heat from one molecule of a gaseous or solid body to another in contact with it. Solids are good conductors of heat, but air is a very bad conductor ;—hence, its utility may be ignored for practical purposes. [On the contrary, solids when cold, withdraw heat from other bodies. In decreasing order of conductivity solids are : metals, stone, wood, wool, silk, porous materials.]

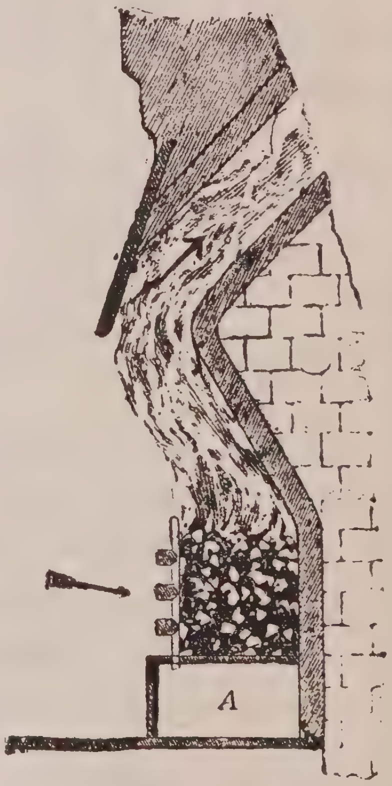
3. **Convection** is the propagation of heat present in a gaseous or liquid body, from one part of itself to another, by movement of its masses. Heated air expands and tends to rise towards ceiling—thereby creating a sort of circulation of air in the room ; but, in a room with cold walls, a man feels cold even if it be full of heated air.

The **Principal means of** heating are :—(1) Open Fire-Place (2) Open Grates, (3) Closed fires or Stoves, (4) Pipes—charged with hot air, hot water, steam and (5) Radiators.

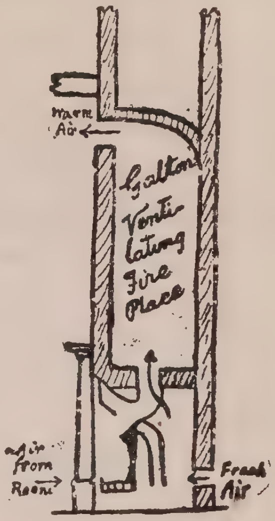
The following are the means of heating individual *rooms* ; to heat a *whole house* uniformly, warm the air of the entrance-hall by (*a*) hot water or pipes, or (*b*) hot water radiators connected with the kitchen-boiler, or (*c*) by a ventilating stove placed in the hall. By means of valved-openings over doors, ascending warmth may be made thus to circulate.

1. **Fire "Place".**—An ordinary fire-place is a flat floor, on which fire is lit; it has these *advantages* : (*a*) cheerful light, (*b*) excellent ventilation and (*c*) warmth ; its *disadvantages* are : (*a*) waste : only 13% of the heat of coal or coke and 6% of that of wood is available to the room, the rest passing up the chimneys without heating the room ; (*b*) creation of draught at floor : in a room with 4000 cub. ft. of space, if 8℔s coal are burnt hourly (each 1℔ of coal requiring 2400 cub. ft. of air for its combustion), 40,000 (*i.e.*, 40,000—2400=37,600) more cub. ft. of air pass up the chimney, changing the air of the room 5 or 6 times an hour ; (*c*) creation of smoke ; (*d*) unequal heating of different parts of the room ; and (*e*) constant attention being necessary.

2. **Ventilating Grate**—is a furnace or confined fire-place. Cold air from outside enters it below, and, after being warmed, escapes into the room above the chimney place.



Its *situation*—is at the back or side of a fire-place in one of the inner walls of the house (so as to help to warm the upper room) but not too much included in it ; or, it may be placed well forward into the room and air should circulate around it. It is *made of* fire clay—no iron being used in its structure ; the *floor* should be a solid slab of fire-brick ; or, if iron-bars are retained, the interval between them should be as narrow as possible and either a shield as high as the bottom-bar of the grate or an iron plate laid upon the bars forming the bottom of the grate, should be made to prevent draught and ensure complete combustion. The *sides* should make an angle of 120° with the back, so that heat from the side may radiate into the room. *Back* should hang forward upto the margin of grate-bottom and the *width* at the back should be one-third of the width in front. The *depth* from before backwards should be equal to the width of the back. The *chimney throat* should be contracted as much as possible or there should be a movable damper to do so. The *fuel* used may be (*a*) coal, which smokes; (*b*) coke, which does not; (*c*) coal gas which does not smoke or cause soot, dust or ashes and can be turned on and off easily, but which is costly and gives sulphuric acid to the atmosphere; (*d*) water-gas—which is cheaper and produces no sulphur compounds but is dangerous on account of the large amount of CO_2 it contains.



Common varieties ordinarily found are—those of Galton, Grundy, Teale, Boyd, Heims, 'Helios', 'Hesta', Neil Arnott &c.

3. **Closed fires or Stoves.**—A *Stove* is a detached fire-place, open at the bottom for a draught-hole (or grated at the bottom for fuel and air) and open at the top for the escape of the products of combustion (by a chimney) and closed on every other side by a material which can absorb and radiate heat well. In rooms heated by stoves, the heated air circulates through the room.

Varieties: (*a*) OPEN OR VENTILATING—those in which fresh air from outside the house is made to circulate through the stove and then, when warmed, allowed to enter the room; here, the air does not come into contact with the products of combustion. Examples: (i) Small jets of gas are lit under the grate, which is filled with asbestos, the latter radiating heat into the room. (ii) Siemen's Regenerative Gas Stove,—wherein the incoming air is heated in an air-chamber, situated behind the grate, so as to be more completely combusted. (iii) Bond's Euthermic Stove. (iv) George's Calorigen Stove. (*b*) CLOSED—which heat the room by convection, no arrangement existing for introducing fresh warmed air into the room.

Advantages : (1) Of ALL KINDS of Stoves : Economy—from more complete combustion of fuel. (2) Of CLOSED STOVES : (*a*) Lesser consumption of fuel ; (*b*) more efficient regulation (by the help of the damper) of the combustion of the fuel ; (*c*) all sides of the stove (and not merely its front) give off heat. (3) Of GAS STOVES : (*a*) They do not vitiate the air of rooms ; (*b*) they do not abnormally dry the air ; (*c*) they economise heat loss by the chimney flue ; (*d*) they are easily lit and regulated ; (*e*) they do not cause smoke, dust or CO_2.

Disadvantages : (1) Of STOVES GENERALLY : (*a*) They are not efficient ventilators. (*b*) They dry the air excessively (unless water is placed in the room or on the stove). (*c*) They produce a close smell, from charring of organic particles coming into contact with them. (*d*) Through the cast iron stoves, products of combustion, specially CO, pass into the room. [Hence, use wrought-iron, with well rivetted joints ; and line the inside with fire-clay covered with tiles]. (2) Of GAS STOVES : They are more costly.

Fuel used :—(*a*) OIL : Mineral oils of good quality only are allowed, and, if their combustion is complete and air-renewal in the room is efficient, oil stove is safe even in living apartments. (*b*) COAL, COKE, PARAFFIN.—If the fuel is introduced at the lowest part of the fire, the stove burns practically smokeless. (*c*) GAS : This is used in 4 forms : (i) *Reflector Stove*=naked gas flame with a metal or glass reflector behind. This vitiates the air of the room, if not provided with an efficient flue. (ii) *Condensing Stove*, wherein the water-vapour resulting from gas combustion and holding in solution the sulphur products, is caught in a tray. This also vitiates the air of the room with CO_2 if not provided with flue. (iii) *Asbestos* (*hollow-ball refractory fuel*) *Stove*=Argand or Bunsen burner incandescing asbestos balls. It is wasteful and vitiates room if no flue is provided. (iv) *Calorigen Stove*—wherein the heat produced in the stove is made to heat a metallic surface, which latter, as well as the heated products of combustion are utilised to heat the room air (*e.g.*, George's Calorigen, Bond's Euthermic).

4. **Pipes charged with hot air or hot water or steam**—These are suited to (*a*) *large* public buildings and (*b*) buildings of *irregular shape.*

(*a*) **Hot air pipes**—are laid in rooms, the air being heated in some other part of the building, the necessity for keeping a fire or stove in the room being avoided. The hot air in the pipes renders the pipes hot, which, in turn, tend to warm up the atmosphere of the room.

(*b*) **Hot water pipes**—are worked only with soft water, are thoroughly under control and safe and worked on two principles: (i) *Low* Pressure System.– There is a boiler in the basement of the building, from which hot water (200°F) circulates through 4″ pipes to the several rooms and when cooled (by radiation), returns to the boiler. (ii) *High* Pressure System (Perkin's).—Instead of a boiler, one portion of small-bore ($\frac{1}{2}$″) pipe is heated to 300° to 350°F., thus subjecting the entire pipe to great pressure and ensuring circulation of hot water. [The low pressure system gives less heat and requires greater length of pipe than the high pressure one. The latter overdries the atmosphere and makes it stuffy].

(*c*) **Steam pipes** are best suited to workshops or factories where steam is readily available. The houses of Parliament are heated on this plan. It is not safe (being liable to cause explosion), nor is it so equable in temperature as the hot-water-pipes system.

5. **Radiators**—are coiled tubular arrangements for concentrating heat within a small area, from which it can diffuse by radiation. They are heated either by (*a*) low pressure steam or (*b*) electricity, which is the cleaner though costlier one. The steam radiator may be utilized also for ventilating the room by conducting outside air through it, into the room.

Draughts vs. Stuffiness.—(1) *Freshness* of an atmosphere is the combined effect of—non-stagnation of masses of air (it moving slowly), of absence of charred or other organic matters and of a temperature of about 65°F. Humidity does not materially affect it, unless inordinately low. Remember that "freshness" of air is no guarantee of its freedom from a large number of microbes ; nor is an offensive odour proof of microbial richness. (2) *Stagnating or Stuffy* atmosphere—is relaxing and depressing alike to the spirits, appetite and muscles and continued breathing leads to a tendency to catch cold. (3) *Draughty atmosphere*—leads to internal congestions and susceptibility to inroads of pathogenic micro-organisms.

(B) COOLING.

A **house** may be kept cool by planting shady *trees* or by having *lake* or creepers on the western aspect of it. To keep a **room** cool, in the day-time, any one or more or these may be resorted to :—(*a*) Prevent direct rays of sun from entering the room,—by means of *closed* windows and doors or by curtains. (*b*) Have *moistened* air-filters—as the khus-khus tatties or thermantidotes or fan-wheels. (*c*) Have constant circulation of air by *fans* and punkhas. (*d*) Have the air condensed and rarefied. (*e*) Have *expansion cylinders.*

(C) LIGHTING.

Desiderata of good light : They are—(*a*) *Comfort i.e.*, the light should not over-heat or over-dry the atmosphere. (*b*) *Healthiness*—from not adding to the atmosphere the products of combustion. (*c*) *Non irritating* to eyesight.

Kinds of light : their merits and defects :—

Sunlight—is the best light. It is favourable to human health and growth and inimical to bacterial growth. The amount and duration of sunlight in a room is a measure of its healthiness.

Coal Gas.—Its *illuminants* are—olefiant gas, acetylene, and benzene (6 % by vol.) ; its *diluents* are—H, CH_4, CO (90 % by vol.) ; its *impurities* are—N, CO_2, sulphur compounds but not H_2S (4 % by vol.). Used with suitable burners and governors, it is cheap, greatly illuminant, and proportionately to its lighting power, is less heating. *The products of its combustion* are :—H_2O, CO_2, CO, ammonia compounds, sulphurous acid, sulphur-compounds. *Dangers of leakage of coal gas are*—(*a*) explosion, (*b*) injury to health from inhaling CO_2 (*c*) injury to furniture from presence in it, of H_2SO_3, and soot. The Welsbach incandescent burner is hygienically the best.

Albo-carbon Light=Coal gas + vapour of naphthalene.

Acetylene Gas, C_2H_2=Calcium Carbide (CaC_2) + H_2O. It gives excellent light but is explosive and emits bad odour. It is not appreciably injurious to health.

Petroleum, Kerosene or Crystal Oil—If a lamp is substantially constructed and oils of more than 100°F flashing point alone are used and care is taken to prevent the vapour formed over the oil in the lamp-reservoir coming in contact with a flame—Kerosene is a very cheap and efficient illuminant. But unless cleanliness is observed and chimney is provided, it is apt to give soot; it is also highly inflammable. Inferior oils have low flashing points and are consequently dangerous, being liable to ignite and cause fire.

Petrol.—Its vapour + air gives a movable, cheap light, more brilliant than electric arc light. But it is highly inflammable. The "Petrolite" for domestic and the Kitson light for public use, are safe.

Candles—are cheap but unhealthy, from incomplete combustion. The unit of light is the 'candle power'—the light produced by the combustion of a sperm candle burning at the rate of 120 grains per hour.

Electric Light : (*a*) *Incandescent Lamps* give good light, do not use up oxygen, do not give to air any products of combustion, do not give much heat, and are, therefore, hygienically the best. (*b*) *Arc Light* is rich in the violet and ultraviolet rays and hence is capable of supporting animal and vegetable growth. It gives very strong illumination.

To produce 16 candle powers light,

	Amount consumed	Oxygen removed	CO_2 produced	Heat calories produced
Tallow Candles ...	2,200 gr.	10·7 cft.	7·3	1,400
Sperm Candles ...	1,740 gr.	9·6	6·5	1,137
Paraffin oil Lamps ...	992 gr.	6·2	4·5	1,030
Kerosene Lamp ...	909 gr.	5·9	4·1	1,030
Coal gas (No. 5 bat's wing burner)	5·5 cft.	6·5	2·8	1,194
Electric bulb	...	0·0	0·0	37

CHAPTER V.

NUISANCES OF TRADE.

Trades that are offensive or dangerous, are often grouped under the heading of Nuisances.

Nuisances are such acts or omission to discharge lawful duty, or such places or things as cause injury, danger, annoyance or offence to the senses of human beings.

Nuisances are **due to** one or more of these :—(1) *Animal* keeping, or slaughter or dealing with their carcasses. (2) *Vegetables*—e. g , boiling linseed or cocoanut oil, or preparing palmitic acid from cotton-seed, foots or palm oil. (3) *Mineral*—dust or vapours. Nuisances pertain chiefly to (*a*) faulty construction, keeping or management of *buildings* and (*b*) improper methods of *receiving*, *storing* and *removal* or *disposal* of such offensive products.

(A) ANIMAL KEEPING.

The animals concerned are horses, cows, buffalos, goats or ewes, donkeys, poultry and pigs.

The SOURCES OF NUISANCE are (1) smell from the food of the animals (kept in all conditions of dirt, moisture and decomposition) as well as their decomposing litter and urine soaking into the ground; (2) bad drainage; (3) presence of rats and insects and specially of fly; and (4) noise. We go into details about stables and byres. Attention to the following details will remove the nuisances:—

Stables.—*Situation*—should be about 100 feet away from dwelling premises. It is not safe to have one's own stable on the ground-floor of the premises. *Surroundings.*—There should be 15 ft. open space all round and this must be well paved. *Dimensions:* Height 12 feet from fioor, and a floor space of 12 ft. × 6 ft. for each horse, exclusive of space for manger, drains, &c., so as to allow 800 c. ft. of cubic space. *Light and ventilation*—should be amply provided for,—by having only a roof and low walls; in cold countries, ample openings may be left in the front wall, with louvres in the opposite wall and roof. *Floor*—should be 1 ft. higher than mesne level, be constructed of impervious material (brick-on-edge with cement or dressed stone) and well sloped (1 : 10). *Walls* should be low and in their lower parts made of impervious material. *Gangway,*—3 ft. wide should be provided between wall and feeding troughs or between two rows of troughs. *Gutter*—should be situated on one side, be of glazed half-pipes or of cement on concrete, be well sloped, covered with an iron grating, flush with the floor. It should lead into trapped and sewered *drain*. *Feeding basin*—must be made of impervious material (stone, iron &c.), be cleaned after each feed, dried and kept covered or upside down, on a raised shelf. Filtered *Water* should be provided in abundance for the drink and wash of the animals and unfiltered water with a hose pipe should be freely used for flushing the place twice a day. If water is drawn from a tank or well, only clean buckets must be used in the manner specified in a separate chapter, *quod vide.* No animal is to be allowed to graze or be washed near such a tank or well. A *separate platform* should be erected on the stable premises for washing the animal. It should be 1/12th of the total floor space, in case of large stables. *Solid excreta and other refuse* must be removed, as soon as passed, in open wire cages, into impermeable and covered bins, to be thence emptied into scavenger carts twice a day. They should be never thrown into ditches or ponds or uncovered *kutcha* bins. *Food storage*—should be avoided, as it attracts rats; on no account must food be stored for more than 4 days and then only in covered receptacles. Food should be served out in necessary quantities and at stated periods only. *Attendant or Syce*—should not sleep on a loft on, or utilize a partitioned portion of, stable for the accomodation of himself and his family.

Byres (for cows and buffalos)—*See* Chapter on Food.

Pigstye.—They are forbidden in towns and must be at least 100 feet away from human habitation, 100 ft. from any water supply. In other respects, they conform to regulations as to stables.

(B). SLAUGHTER HOUSE (ABATTOIR).

Private slaughter houses should be abolished to minimise the risk of tuberculous or other diseased meat being sold, and the place rendered insanitary. Public abattoirs are of two patterns: (1) *Block* or *German system*—where all buildings are under one roof. (2) *Separate* or *French system*—in which each butcher has a room where he can slaughter—such rooms opening at one side into a common passage and at the other directly outside the abattoir. The latter is suited to the tropics. A **public slaughter**

house (*a*) must not be *situated*—within 100 ft. of human habitation, so that the cries of animals may not be heard nor slaughtering overlooked from neighbouring houses; (*b*) must not have any *rooms* or *lofts* over it or any stable, cesspool, watercloset or *privy* within or in communication with it; (*c*) must be thoroughly *ventilated* but must have fly-proof windows; (*d*) must have impervious *walls*, concrete or asphalt *floor*—the latter being well sloped and *drained* to a gully with trap and grating; (*e*) should be above the general *level* of the ground; (*f*) the *approach* to it should not be on an incline of more than 1 : 4, must be well paved and should not pass through any dwelling house or shop; (*g*) the *water tank* must be situated at least 10 ft. above floor level; (*h*) the *lair for the beasts* must be properly paved, drained and ventilated; the cattle *yard* must be turfed.

It should be regularly inspected and all meat should undergo an ante-mortem as well as post-mortem inspection. All their blood, fat, oil, bile, hoofs, sinews, intestines, skin, bones together with garbage should be put into covered vessels of non-absorbent material and removed within 24 hours. Meat should be inspected and stamped as to its quality and sent out to markets hung in wire-netted vans locked and sealed.

An abattoir must provide **accomodation** for these: (1) *Cattle yard*—where butchers can purchase stock from dealers; this may be turfed. (2) *Lairage shed*—(separate for sound and diseased animals) where animals can rest preliminary to slaughter, as rest for a few days improves their meat. (3) *Inspection sheds*—where animals can be medically examined. (4) *Waiting sheds*—where animals are taken immediately before slaughter. (5) *Killing-house.*—These five should be completely separated from each other and well constructed. (6) Room for cleaning *utensils.* (7) *Incinerator* to destroy unsound carcasses. (8) *Ice-making room* and *cold storage.* (9) *Laboratory* for tuberculin injections and examinations. (10) *Offal house.* (11) *Manure* house. (12) *Boiler* house. (13) *For butchers*—waiting room, restaurant, water-closet, market-room &c. (12) Building for *horses*, *vehicles* and *drivers.* (13) *For officials* and inspectors—offices, quarters &c. The area of ground thus required is extensive, being roughly 6½ sq. ft. per inhabitant in towns of 3000 inhabitants, 3½ sq. ft. for 10,000, 3 sq. ft for 50,000 and 2½ sq. ft. for over 50,000 inhabitants.

(C) INDUSTRIES ASSOCIATED WITH THE BYE-PRODUCTS OF SLAUGHTER HOUSE.

Measures of General Sanitation.—(1) Situate these factories in suburbs, at least 100 ft. to the leeward side of human habitations. (2) *Buildings* must be of brick with impervious inner wall and floor, the latter inclined 1 : 30. (3) *Light* and *ventilation* must be sufficient. (4) *Drain*—trapped and sewered. (5) *Water supply*—copious. (6) *Receptacles* for storage or removal of products must be made of impervious material, with close-fitting covers and of sufficient capacity. (7) *Foul matters* must never be allowed to get encrusted on walls, floor, fittings, receptacles etc. (8) *Noxious Vapours* must be destroyed or abated by one of these measures :—(*a*) condense them in steam-jacketed cylinders ; (*b*) absorb them in some solid or in the water of a washer or condenser ; (*c*) cremate them in the fire by passing them into the furnace or employ destructive distillation of them or (*d*) discharge them through very tall chimneys.

Other Special Measures adapted to individual cases :—

Blood—is dried or boiled to prepare—blood-albumin, turkey-red pigment, blood for sugar refiners, manure &c. *Remedies* : (1) Fix the blood or mix it with acid in closed chambers ; (2) when not in use, blood must be kept covered.

Bone, Hoof, Hide.—Their trimmings are boiled to produce glue, gelatine, and fat ; bone is used as handle or crushed and mixed with H_2SO_4 to produce superphosphate manure. *Remedies* :—Properly store them, preventing too much accumulation ; thoroughly clean and lime wash them ; boil them in steam-jacketed pans and condense the vapours ; cool the waste liquor before discharge into drains. Properly store recently boiled bone.

Stomach—is boiled for food. **Intestines**—are salted and scraped for preparing sausage-skin and catgut. *Remedies* : Most careful conveying in sealed vessels ; strong ventilation of scraping-room ; use deodorizers like sulphite of soda, chlor-alum etc.

Fat—is melted for preparing candles, leather dressings, soap making. *Remedies* : Proper receptacles for storage and conveyancing of fat (usually decomposed) and of waste residue.

Skin : (1) *Fell-mongering*=cleaning skins of hair, flesh and dirt and working lime into them. (2) *Dressing and Tanning*=converting into pliable non-putrescible leather. *Remedies* : Proper storage, water-tight lime pits, which should be emptied daily ; satisfactory disposal of waste water, dirt and flesh. Skins treated with arsenic are to be treated with salts of iron before discharge into gutters.

Fish—may be dried or fried. *Remedies.*—Proper house ; proper storage receptacles ; use best dripping, instead of the same oil for a long time.

All animal waste—mixed with minerals to form artificial manures. *Remedies* : Have specially constructed house and special arrangements.

Markets.—Fish, meat and vegetable markets should be separated from each other by a 10 ft. wide stone-metalled passage on all sides, connected only by short, covered passages. Market should be *situated* 100 feet away to the leeward of dwellings. No dwelling room or loft should be built on it. Its *floor* should be at least one foot above the ground level. It should have more than one wide *approach*. It should have well-cemented (or better still, marbled) *floor*, with good incline on either side, into glazed half-pipe gutters ; they should lead into trapped and grated gulley, communicating with public *sewer*. The *walls* upto a height of six feet should be of glazed tile or well cemented. They should not rise beyond 8 ft., being connected to the ceiling by means of iron-railings and provided in those open parts with hinged sash-doors. The *roofs* should be high and provided with sky light and ventilators. Marble tables (or tables covered with galvanized sheeting) with side channels should be provided ; hooks and pegs from the ceiling must also be provided. *Lighting* should be by electricity or Welsbach lamp.

Latrine and *sanitary conveniences* should be provided in a detached building. Supply of filtered *water* and unfiltered water with hose-pipes should be liberal. An army of *servants* with wheel-barrows should be in constant attendance and regular *inspection* of edibles made by sanitary staff. *Vessels* used must be either of glass, stone, china or enamelled-ware and *scales* and measures must be kept scrupulously clean. Loafers and diseased vendors or persons should be rigidly excluded. *Seats* separate from the edible tables should be provided for vendors. The *streets around* markets should be kept constantly clear of horse droppings and vegetable debris and well watered or oiled. Sufficiently wide *gang-ways* should also be provided.

Bake house—No underground room is to be used as a bake house. Each process should have a room to it. No water closet, ashpit, sewer, or privy should be within it or communicating with it. It should be well lighted and ventilated and never used for sleeping. Floors should be well cemented in concrete and walls should be kept clean and lime-washed.

(D) NUISANCES OF VEGETABLE ORIGIN.

Grains—are heated by steam or boiled. *Remedy* : Have proper premises for storage and mechanically ventilate the drying room.

Jute Steeping in tanks. *Remedies* : Erect sheds over the tank and discharge the vapours by a high chimney; purify the effluent before discharge into any water-course.

Textile Trades : Dust, fibres, excessive humidity, and ill-ventilation—are the causes of menace to health. Their *preventives* are : use pure water for steam-production ; the CO_2 in the shed must not be more than 9 per 10,000 volumes of air ; introduce 2000 c. ft. air per head per hour.

Paper Making.—Waste cotton and linen rags, in all stages of filth and contamination, wood pulp, hemp, straw, waste paper and sabai grass are freed from dust, boiled with caustic soda and treated with other caustic chemicals. These processes and the process of recovering soda from the liquor and the storage of the materials give rise to nuisance : *Remedies* : The fumes should be conducted into tall chimneys, all waste liquids should be run only into sewered drain, never into ditches or ponds.

(E) NUISANCES OF MINERAL ORIGIN.

Chemical Works—should provide for condensing or destroying vapours or treating them with chemicals that will produce useful bye-products. Manufacture of oxalic acid from sawdust, distillation of wood to produce methylated spirit, making of coal gas, distillation of tar, manufacture of carbolic acid, making of sulphuric acid and salt, of chloride of lime, of glass of tin-plates, of coke-breeze, and of bricks and cement, the burning of tin, of lime, of ballast, and of pottery, the calcining of arsenical ores, the smelting of copper—all give rise to irritating fumes. *Remedies* : Free ventilation ; use of damped flannel respirators and suitable hood and flue assisted by a suction fan.

Gas Works.—should frequently remove the lime wastes and use sesquioxide of iron to remove sulphur, and lime to remove CO_2.

Other offensive trades are : Artificial manure making, india rubber making, varnish making, manufacture of alkali and of horse-hair, wool-sorting &c.

(B) DANGEROUS TRADES.

Workers in minerals and chemicals are often the victim of incurable diseases or of death. The symptoms of the diseases produced in workers and the treatment of such diseases have been discussed in detail in the Author's *Outlines of Medical Jurisprudence and Treatment of Poisoning*. We consider them in our present relations as hygienists :—

Lead.—When in a state of fine sub-division, it is absorbed through unbroken skin by sweat, alimentary and respiratory passages. Hence all lead-workers should be (*a*) protected from lead dust by exhaust-fans, respirators and overalls with close-fitting collars and cuffs ; (*b*) provided with clean, well-ventilated workshops and liberal supply of water and towels : (*c*) disallowed drink and meals on the premises ; (*d*) regularly dozed with milk and acid sulphuric lemonade and (*e*) subjected to periodical examinations for suceptibility and for breaches of skin surface.

Phosphorus.—Poisoning occurs by inhaling its fumes. Workers should be protected by these precautions : (*a*) Red phosphorus alone should be permitted in the workshops and dipping, drying and boxing should be done by machinery ; (*b*) work is to be done wearing charcoal respirators, in the open air, or in short shifts, or near fume-extraction-fans, on under an atmosphere impregnated with turpentine fumes ; (*c*) food and drink must be disallowed on the premises, alkaline mouth washes, extreme personal cleanliness and periodical examination of teeth should be insisted on. [The fumes from the moist heated paste are the most dangerous].

Mercury.—Poisoning occurs by inhaling fumes or eating food or drink contaminated with the metal. *Prevention :*—Allay dust and fumes, observe absolute personal cleanliness, avoid food and drink on the premises, keep mouth rigidly clean and fill up carious teeth, construct the workshop floor so as to lead to collection of every grain of mercury spilled, keep the mercury in covered receptacles and during off-hours permeate the workshop with fumes of ammonia.

Arsenic.—Poisoning occurs by inhaling its sublimed fumes or by constant contact of arsenic with skin or by food contamination. *Preventives* : Same as in case of Lead. No arsenical waste should be discharged into a stream.

Bichromates and other Chemicals—With bichromates may be included the manufacture of Hydrochloric Acid, Sulphuric Acid, Bleaching Powder, Carbon Bisulphide, Alkalies most of which are associated with evolution of Cl, H_2S, SO_2 etc.—Those fumes are all very irritating and often fatal. *Prevention*—same as in case of lead.

Inflammabie Paints ; Benzine :—They catch fire easily and when inhaled cause collapse. *Preventives* : Avoid naked lights ; never work for more than 1 to 2 hours without breathing pure air ; work only in well-ventilated rooms.

Aniline, Dinitrobenzine.—Poisoning is by inhaling fumes and vapour. *Preventives* : Lofty, cool, ventilated workshops ; personal cleanliness ; avoidance of eating on the premises ; short shifts of work.

Explosives :—Little risk to health is caused in the factories ; but of course an explosion is always dangerous to life and limb. When, however, explosives are worked inside mines, they evolve so much CO and CO_2, as to lead to collapse and death and every precaution should be taken there while blasting operations are in progress, specially in respect of men who are subjects of chronic pulmonary or bronchial affections.

CHAPTER VI.

WATER.

Uses—as a necessity of life ; *e. g.* for purposes of—(1) Drinking and making respiration, elimination of the waste products of body, maintenance of body-temperature and building of tissues possible. (2) Washing and cleaning body and various other articles. (3) Commerce and travelling. (4) Use as a universal solvent. (5) Power generation.

Physical Properties of pure water.—Clear, transparent, odourless, tasteless, colourless in small quantities, but greenish-blue in bulk, and practically incompressible. Its *volume* varies with temperature ; its *maximum density* is at 4°C ; it expands when heated and in freezing also expands 1/11th of its volume. Its *boiling point* is 100°C or 212°F, at ordinary barometric pressure, (760 mm. of mercury) ; but it boils at a lower temperature if pressure be reduced (as at elevations) ; when converted into gas, it occupies 1600 times its original volume. Its *freezing point* is O°C or 32°F ; but, if charged with salines, it freezes at a lower temperature and in the act of freezing, loses some of its salines. It *evaporates* invisibly at all temperatures. It is a very ready *solvent* of gases, and solids ; that is why rain water, originally pure, imbibes soot, dust, H_2SO_4 &c., while falling. When a body passes from the solid into the liquid state or vice versa, a large quantity of heat is absorbed or rendered *latent* ; and of most other liquids, water has greater latent heat. But water is a poor *conductor* of heat. *Specific heat* is the amount of heat required to raise a unit mass of body through one degree temperature. Weight for weight and for the same rise of temperature, water absorbs more heat.

Chemically,—water is neutral in reaction and contains only hydrogen and oxygen.

"Pure" water.—Water very easily takes in solution gases, salts and organic matter ; hence, *chemically pure* water is unknown, unless a sample of water has been repeatedly distilled in silver vessels. On account of its great dissolving power, when chemically considered, water is of two—

Kinds—Hard and soft waters.

1. **Hard** Water—is water which holds in solution volatile CO_2, fixed acids or calcium or magnesium carbonate or sulphate to the minimum extent of 10 grains per gallon. It is mostly DERIVED FROM chalk, oolite, limestone, red sand stone &c. Hardness of water is either—(*a*) *Permanent*—when it

is not removable by boiling the water, being due to calcium and magnesium chloride, phosphates and nitrates ; *(b) Temporary* —when the hardness is removable by boiling the water or using caustic lime or soda, being due to bicarbonate of calcium and magnesium. *(c) Total hardness*—is that which is present before boiling the water. It is caused by salts of calcium and magnesium with some free CO_2.

DISADVANTAGES of hardness of water : *(a)* It lays down a coating or '*fur*' *inside boilers*, thereby leading to—*waste* of fuel and *explosion* of boilers. (*b*) It prevents heat penetrating between fibres of muscles and vegetables put into it to boil—leading to *bad cooking*, less flavour and uncanny appearances ; thus, it leads also to *gastro-intestinal disorders.* (*c*) It causes *waste of soap* in washing (1 gr. chalk requiring 8 gr. soap ; or, 1 ℔ soap requiring 1000 gallons of hard water.)

TO REMOVE HARDNESS (*temporary*),—add *caustic lime or soda* (1 oz per 100 gallons) to water containing bicarbonate of calcium or sodium, *carbonate of soda* to one containing sulphate of lime.

ESTIMATION OF HARDNESS : Amount of hardness is expressed (*a*) in terms of grains of calcium carbonate per gallon (Clarke's system) or (*b*) as parts of calcium carbonate per 100,000 (metrical system). Thus, 1° *Clarke* (= 1 gr. $CaCO_3$ per gallon) = 0·7° *Metrical.* Total hardness must not exceed 0° metrical (of which the permanent hardness should not exceed 5° metrical)—for, the greater the permanent hardness the more objectionable is the water.

2. **Soft** Water—*i.e.*, water which does not hold in solution salts of lime or magnesia. ADVANTAGE—is that none of the disadvantages or dangers of hard water is present. DANGERS—It can absorb CO_2 from air readily and hence can dissolve out zinc, lead and iron from vessels in which it may be kept or pipes, through which it may be conducted.

Sources of natural water.—**Ocean-water** is the indirect source of all waters, for, after evaporation, it comes back to the earth as **Rain** and Snow, and it is from rain that we have these direct sources : (1) Rainfall. (2) Upland-surface water, (Lakes, Ponds &c.) (3) Streams and Rivers. (4) Springs. (5) Wells.

Snow and **Ice** rarely act as sources of supply of water. Ice prepared from water polluted with organic or bacterial contamination is positively dangerous. **Distilled water** prepared from sea water and used on voyages, is unfit to be used, unless well aerated. *Aeration* of boiled or distilled water is easily effected by pouring it several times from one vessel to another, through space. Distilled water should never come in contact with copper, lead or zinc. Block tin is safe for storing such water. *Rain* as it falls, is the purest form of natural water, and the ultimate source of replenishment of all sources of water-supply.

I.—RAIN.

Natural disposal of Rainwater—About 6/10th of the average rainfall is available for water supply, the rest is naturally disposed of in three ways : (1) **Evaporation** (from surface of soil and vegetables): The amount of rainfall lost by evaporation is always in excess of that by percolation ; and is greater, the higher the temperature (except such portion of rainfall as lies in sandy or gravelly beds). (2) **Percolation**—into the sub-soil ; this aborbs CO_2 and minerals and is returned to surface as spring or as well or tank water. (3) **Stream-formation**.

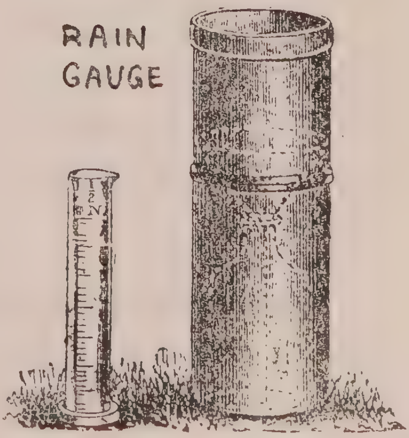
Rain water for drink—**Disadvantages** :—For purposes of drink, rain water entails *heavy expenditure*, is *uncertain* in supply, and is not safe, for, if kept in lead, zinc, galvanized iron or iron tanks, it *becomes poisonous*. If, however, rain water must be stored, care should be taken to **prevent** (*a*) the first portions of rain getting into the tank, by using Robert's Rain Water Separator or other means ; (*b*) any subsoil water percolating into the tank ; and prevent (*c*) contamination of tank water by birds, animals or man.

Collection.—For purposes of storage, rain water may be collected from (*a*) sloping roofs of houses ; or (*b*) by collecting it over large clean sheets spread out in the open. Thus collected, it is **stored** in—(1) *Troughs* or *Tanks*—well concreted over slate, asphalt or cemented area, so as to exclude contamination by subsoil water. (2) *Underground Tanks*—built on impermeable masonry work, lined on the interior with hydraulic cement and surrounded externally by 1″ well puddled clay. Water of this tank does neither freeze in winter nor becomes too hot in summer.

Amount of Rainfall—As a source of water-supply, it is inconstant, as it varies in different parts of the earth, being more in the tropics than in colder climates and more where vegetation is abundant than otherwise. In—

(*a*) Driest seasons it is ⅓ less
(*b*) Wettest ,, ,, ,, ⅓ more
} than average

The amount of rain-fall is **measured by** a *Rain Gauge* wherein 1″ fall of rain equals 4¾ gallons of rain-fall on a square yard of ground. One foot of dry snow represents one inch of rain fall. The annual rainfall^{S} in India are : at Cherapunji—600 inches, Mahabaleswar, 253, Moulmein, 180, Cannanore 121 inches.



Characters & Impurities: (1) **As it falls,**—rain water is pure, well-ærated and soft, and therefore, *fit for* cooking and washing, but *unfit* to be stored in vessels of zinc, lead or iron. In **Manufacturing Towns**—it acquires, in its passage through the air, specially in its earlier portions, ammonium carbonate, nitrites and nitrates, nitrous and nitric acids, sulphurous and sulphuric acids, carbon &c.—due chiefly to coal and decomposing organic matters. It is very good for baths in towns whose water is hard. In **Towns & Villages**—it catches from the air, bacteria, fungi and their spores, pollens of grasses and flowers, animal excreta, minute particles of hair, straw &c. In **Sandy Deserts**—it catches dust, which, as well as the microscopic plant protococcus pluvialis, causes coloured rain. In **Sea coasts**—sodium chloride and sulphates get dissolved in the falling rain water.

II.—UPLAND SURFACE WATER.

Source: Streamlets flowing off the sides and surface of *hills*, after a downpour of rain, furnish the upland water-supply as pond or lake. The **ideal source** is one which flows through districts uninhabited by men and animals, uncultivated and free from peaty areas. But often water may become **contaminated by** (*a*) flowing through moorlands with much peaty matter, (*b*) by lime salts, if through calcareous soil, (*c*) by nitrates and nitrites, if through cultivated or manured lands and (*d*) by chlorides, if flown through thickly inhabited districts.

Means of Collection.—Unless the water thus flowing down hill sides is caught (or impounded), it is not available for use. The collection often naturally occurs by the water running into a lake. Collection, therefore, is natural or artificial :—

I. **Naturally** *into Lakes*—which require only to be tapped for human use, as, Loch Katrine is tapped by Glasgow. Their water is soft but rich in nitrogenous matter.

II. **In Impounding Reservoirs** or Tanks (artificial),—as in Lancashire and Bombay. *To divert the natural streamlets* into these reservoirs, dams are built partially across the outlet of the valley, leaving some outlets—(i) as compensation (= ⅓ the total amount impounded) to pass down to mills below; and (ii) for diverting the stream from the reservoir, in case of fouling of feeding streams by flood &c.

Such reservoirs are *built by* excavating or embanking the soil, at such height from the general country-level, as to ensure, by the force of gravitation only, a jet of 20 ft. above the highest height of building. *Floors* and *sides* of these reservoirs should be well concreted or lined well with puddled clay, avoiding common mortar, as the lime of it is easily dissolved out by the water. The *size* of it will depend upon the mean rainfall, the average percolation and evaporation and on the population.

Characters.—It is soft, comparatively free from minerals, nitrites, nitrates, ammonia and chlorides. Water however, flowing through calcareous soil is hard.

Impurities: There are three sources of contamination according to the area over which the water has flown :—(1) *Peat* (from moorlands).—It renders the water yellow or brown, bitter and acid (from presence in peat of acid-producing bacteria); this acidity is responsible for "plumbism", when such water is led through lead pipes. To purify it, filter the water through sharp fine sand. (2) *Algæ* or *Microscopic organisms*—if the reservoir is kept uncovered and exposed to light—These, too, colour the water red or greenish blue and render it turbid and evil-smelling, but not unwholesome.

Filter the water before use. (3) Pollution from *huts* and *droppings* of animals living above the reservoir. Such water contains nitrates, nitrites and chlorides in large amount and is positively dangerous.

Rules for Potable Tank. (1) There should be at least one tank in every village, exclusively set apart for drawing *drinking* water. (2) Water from it should be drawn from a *platform* substantially built over it—never by going into the water. (3) It should be *situated*—at least 50 ft. away from any marsh, dwelling house, bazar, manure heap, cess pit, drain, trenching or cultivation ground or other sources of contamination. (4) It should be stocked with *live fish*, specially of the smaller varieties, and be substantially *railed off* on all sides and not fenced off haphazard. (5) No one should be allowed to go into the water, either for drawing water or bathing or washing vegetables, rice or clothes or rowing or catching fish or should spit or ease oneself in or near it. Weeds, watercresses and "pana" should be removed—from the shores. (6) The sides should be elevated above the general level of the village and should thence be well *sloped* in and *turfed* and no cattle shoud be allowed near them. (7) There should be *no trees* near or above it and no drain or cess pit should discharge into it.

Tanks are abundant in Bengal where their multiplicity is a source of embarrassment to the inhabitants. To ensure the health of the people, one tank in each village *must* be kept apart for drinking water and too many small ones should be either filled up or not allowed to be excavated at all.

III.—STREAMS & RIVERS.

Sources & Feeders :—Rivers are derived from streamlets of surface water, percolating subsoil water and springs; melting snow and ice and flood swell the volume of rivers

Composition: River water holds in solution—*Gases*: Nitrogen CO_2, H_2S. *Minerals*: aluminium, iron, lime, magnesia, potash and soda as chloride, carbonate, phosphate or sulphate. *Solids*—vegetable or animal matters; nitrates, nitrites &c.

Where River water is pure:—(1). Near its source. But here, the water is harder than in its lower part. (2). Where it passes through uncultivated land on hills or uninhabited moorlands. (3). Where the volume of water is considerable, the current swift, and the river abounds in fish. *When River is polluted with sewage* &c. its water is safe at (1) parts above sewage-outfall and at least 10 miles above any village situated on its bank; & (2) the midstream, at least 20 to 30 feet beyond any bank.

Sources of contamination:—River water becomes impure on account of—various kinds of geological strata, manured lands, burial or trenching grounds passed through; washing through mines of lead, mica or coal; flood carrying animal and vegetable matters; factories, septic tanks, drains &c. discharging into it; partially dried bed of it being used by men and cattle to ease themselves on, water subsequently flowing through such beds in the rainy season; enormous pilgrims bathing and otherwise polluting it periodically.

Purification.—River water undergoes a good deal of self purification by (*a*) the *physical processes* of—subsidence and dilution and (*b*) the *chemical actions* of oxidation, sunlight, bacteria, infusoria, vegetations and fish. Falls and eddies, by increasiug the oxygen-content and by letting in sun's rays increase its purification.

Storing River water. From the middle of fast flowing streams, at a level below the lowest summer level, by means of screened pipe, water should be drawn by pump to subsidence reservoirs, before being used for drink.

IV.—SPRINGS.

Springs are—jets of subsoil rain water forced by pressure ("head") to the surface.

Sub-soil Water—steadily *percolates* deeper into the soil—specially if the soil is sandy, gravelly or chalky (fissured)—till it meets with an impervious layer of clay or rock, where the pressure of the entire mass of accumulated water forces it to *move constantly* in one direction, till it falls into sea water or is forced up into the surface of the soil, as a spring. The *level* of subsoil water—depends on the amount of rainfall and percolation, rising in February and March and falling in October and November—such variations being fairly regular. A *cross-section* of the subsoil water presents a curve from its highest level to its outlet, the curve being steeper near outlet and more horizontal, the farther from it.

Classification : This is based on (*a*) depth at which the impervious layer exists, and, therefore, on (*b*) the constancy or otherwise of the supply. The usual classes of spring are :—

Land Spring—is an outlet of *limited* collection of subsoil water overlying a comparatively superficial impervious stratum. It is usually seen on slopes and is intermittent owing to the available porous collecting area being small. Where the porous layer happens to be deepest, a pocket forms and the supply ceases until prolonged rainfall occurs. **Bourne or Intermittent spring**—is formed by the highest level of subsoil water being tapped by a comparatively low-lying *valley*. Both land and intermittent springs are very liable to pollution and to stop during summer (April to September).

Main or Deep Spring—is a jet issuing from a fissure or fault in the overlying stratum through a great thickness of regular geological formations like chalk, oolite, limestone, millstone. Its water is pure, sparkling, well-aerated and constant (*i. e.* the supply is independent of periodical rain fall) but is hard, being unfit for cooking, washing or machinery. Some of these may hold in solution too much mineral matter, becoming unfit for domestic use but gaining in value as therapeutic agents.

Thermal spring—which traces its origin in a volcanic district or in the deeper regions of the soil.—The Sitakoond and the hot springs of Buxton and Bath are instances in point.

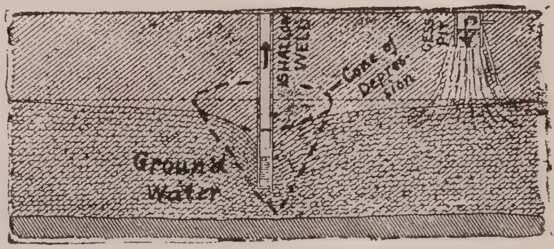
As sources of water-supply : *Advantages* (1) They are pure (specially when from deep springs), sparkling clear, and of constant temperature throughout the year. (2) They do not require filtration nor land for storage. *Disadvantages :* (1) The water is most often hard and (2) can supply only small communities (specially in cases of shallow springs).

To guard against pollution : (1) From the point of delivery, pipes should conduct away the water. (2) Around the point of delivery, the surface of the soil should be cemented and walled in. (3) If necessary, store it in elevated reservoirs by means of ram, turbine or pumping engine.

To calculate the total yield of a spring—fill up a vessel of known capacity ; then by the time taken to do so and from a knowledge of the annual flow, deduce results.

V.—WELLS.

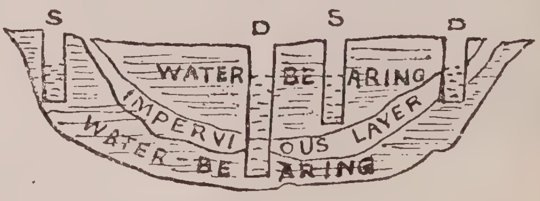
A well is a hole dug into the permeable ground for tapping the sub-soil water.



Area of Ground water tapped by a shallow well :— The area is roughly speaking an inverted curvilinear cone, with the bottom of the well as apex—being roughly four times the depth of the well. The size of this area *depends on* (*a*) the permeability of the soil, (*b*) the amount of pumping, *i.e.*, the amount of depression of water-level and (*c*) depth of the well. [Hence, **if too much water is drawn** from a well, or a pump is too freely used, a cone with a wider base is created and, therefore, contamination from within a very wide area is hastily sucked into the well.

Position of a well—should, therefore, be, in the case of SHALLOW WELLS—at a distance of 100 to 160 times the cone of depression of water in the well that is ever likely to be caused by pumping—away at least 350 ft. from sources of pollution (*e.g.*, cultivated lands, cesspools etc.) The utmost distance from which A DEEP SURFACE WELL can be polluted is half a mile. A well should be situated also in a direction *opposite* to the natural course of the subsoil waters.

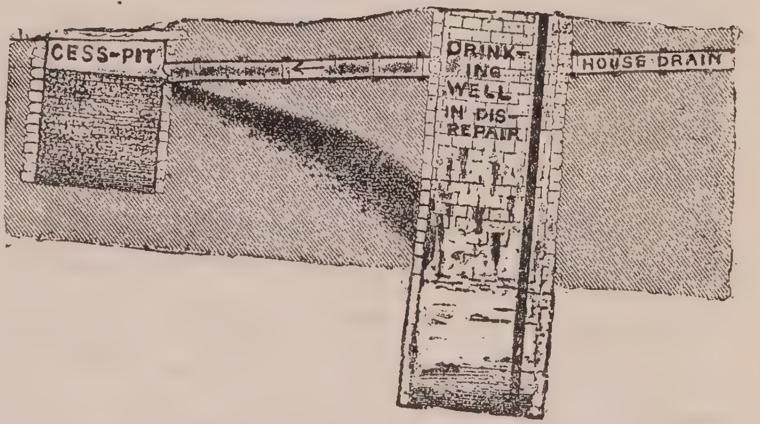
Classification of wells : They are of four kinds : shallow, deep, Artesian and tube wells.



I. Shallow or surface wells : Whatever their actual depths, these tap sub-soil water-bearing-strata lying *above* an impervious bed. They are usually less than 50 ft. deep, and very common in India.

CHARACTER OF WATER: As a rule, clear, sparkling palatable; but frequently hard and loaded with ammonia, chlorides, nitrites, and nitrates—all which point to organic contamination. The water therefore is *dangerous.*

SOURCES OF CONTAMINATION—are three in number :—



(1) Subsoil water passing through contaminated soil, may carry in solution contaminations from leaky cess pits, drains, privies, cow-sheds, grave yards etc. situated in that soil into any well which is shallow or has leaky walls and which is situated in the direction of the flow. (2) *Too hard pumping* may suck water from neighbouring cess pits, middens etc. (3) *A sudden rise of ground water* may establish direct communication between a shallow well and cess pool hitherto untapped.

As bearing on the question of water contamination, the following table will be useful :—

Viability of pathogenic bacteria in soil.

(1) B. Typhosus, in England, in ordinary soil lives 74 days; in Sewage polluted soil, 74 days; in Fine dry sand, 24 days; in Peat, 13 days; in Dry as dust soil 25 days. In India, in dust contaminated with urine 5 days, in dust exposed to June Sun (17 hours at 53°C) 3 days. (2) B. Diphtheria in moist soil at 26°C, 2 months; in moist soil at 30°C, 17 days; in dry soil, 1 week. (3) B. Dysentery, 21 days. (4) B. Comma in dry soil, 3 days; in undressed soil, 12 days; in moist soil, 33 days; under bell jar, 40 days. (5) B. Plague in dry soil above 20°C, 1 week, in moist soil below 16°C, several weeks.

II. Deep wells—bring water from either (*a*) below regular geological strata; or (*b*) water-bearing strata lying *below* one or more impervious strata. Actual depth is of no count.

CHARACTER OF WATER—varies with the kind of strata passed through, being in every case, clear and pure. It imbibes CO_2, and calcium carbonate when from chalky parts; calcium and magnesium sulphate when from lime-stone or magnesium lime stone; sodium chloride and carbonate when from granite, metamorphic and trap rock; calcium and magnesium carbonate and sulphate when from mill-stone grit and oolite. If situated in the centre of a town, it is pure—but may contain nitrites and nitrates; if near the sea, chlorine is found in the water and it produces gastro-intestinal trouble. The water is often hard. Occasionally, liquid filth finds its way into the fissures in the geological formations (chalk, sandstone etc.)

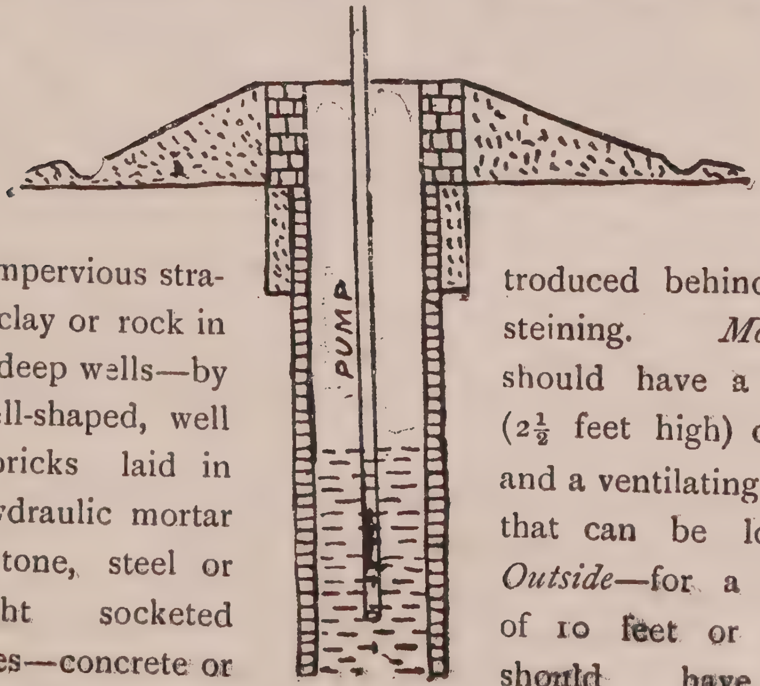
The waters of—*Behar and Muzaffarpur*—are hard, containing large amount of calcium salts; *Midnapur and Bankura*—contain iron (ferric and aluminium hydrates); *Raniganj*—is good, as is deep well water in all coal districts; *Barakar*—is pure as the soil contains gneiss and laterite; *Orissa* (sea coast)—contains chlorides.

THE TEMPERATURE of deep wells increases roughly 1°F for every 55 ft. in depth below 60 ft., at which, it is practically uniform at 50°F.

III. Artesian Wells—(from 'Artois' where they were in use) are wells sunk into an underground reservoir of water, confined within an impermeable stratum above and another below. They partake of the characters of *deep* wells.

IV. Norton's Abyssinian or Tube wells are borings into the earth by means of pipes (1¾″ to 3′ diameter) screwed one to the top of the other and weighted or hammered down to a depth of 20—30 feet, to tap the superficial subsoil water. They serve temporary purposes and are worked by hand pumps. They are best driven into the bed of an ordinary well or an old river (as was done at Katihar) ; but they do equally well in gravel, coarse sand or chalk. These partake of the characters of shallow wells, and all precautions regarding the latter apply to them. Character of Water :—Their water is fairly good and cool. They have been much used in Rangpur district and they are sunk when the superficial supplies are known to be polluted.

Rules about wells.—Each village should have at least one well strictly set apart as a source of drinking water-supply —well away from human habitation, cultivation fields, privies etc. *Its situation:* If a deep well, anywhere away from live sources of contamination ; if a shallow well, at least 350 ft. away from dwellings or other sources of contamination and always above such sources. From drains, it should be at least 4 ft. away for every foot depth of the well. *Inside* should be lined—throughout in the case of shallow wells, and down to the level of the impervious stratum of clay or rock in case of deep wells—by hard, well-shaped, well burnt bricks laid in good hydraulic mortar or by stone, steel or water-tight socketed iron pipes—concrete or puddle clay being introduced behind this steining. *Mouth :* should have a small ($2\frac{1}{2}$ feet high) coping and a ventilating cover that can be locked. *Outside*—for a radius of 10 feet or more should have a cemented sloped plat-



form, ending in a gutter leading to a long concrete drain. *Draw water*—by a separate iron bucket with iron chains or by pump. *Guard against* occurrence of any of these : (*a*) Use of any private bucket ; (*b*) Bathing, washing or ablution in, or within a radius of 100 yards of, the well ; (*c*) Washing or grazing cattle within that radius ; (*d*) Growth of vegetables inside or of trees outside the well ; (*e*) Formation of pits or rat-holes. It is better to have one or more reservoirs (chowbachhas), fitted with stop cocks, into which water can be stored directly from the well and from which water can be drawn by turning the stop cock.

Points for examining wells : **Its surroundings** : Note (1) Nature of *soil* and *sub soil*, as regards porosity. (2) *Distance from sources of pollution* (cess pits, middens, sewers, burial grounds, manure heaps, leaky drains, trenching grounds) and from *human habitation.* (3) Condition of *ground around* the well (cemented or not, clean or otherwise) (4) Method of *disposal of waste water.* **Its Mouth** : Note—(1) If the mouth is kept *covered.* (2) Condition of pump or *drawing materials* (clean or not). (3) Condition of *cement* of the parapet wall. **Inside** : Note—(1) *Depth* of water in well. This is important ; because, a sudden rise of ground water may cause direct communication between the well and a hitherto untapped cess pool. (2) *Distance* of water-level from ground-surface. (3) *Depression* of water level caused by pumping and the *time* taken to regain former level. (4) *Depth* down to which the sides are protected by mortar etc. (5) State of the *cement* or *joints* in the cylinders (cracks, etc). (6) Presence or absence of vegetation on the walls.

Take sample of water—(1) from near surface and (2) from near bottom. **To detect source of pollution**—A solution of sodium chloride or of lithia salts or paraffin oil or an alkaline solution of fluorescine or emulsion of B. prodigiosus should be poured into cess pits or drains and if they are recovered in the well water, the chain of evidence is complete.

Yield of water in shallow wells—can be calculated by pumping down to a certain level and noting the length of time taken to regain its original level. [The quantity of water (in gallons) is estimated by the help of this formula :—

$H \times D^2 \times \cdot 7854 \times 6 \cdot 23$, where H is the height and D is diameter at base.]

In India, a well is polluted because of : (1) washing clothes, soiled perhaps with cholera dejecta, on tops of copings ; (2) immersing vessels scrubbed up with mud drawn from nearest puddle ; (3) bathing, or cleaning cooking utensils or easing oneself near the well ; (4) bathing and watering cattle near it ; (5) dried leaves of trees planted around it falling into the well.

To clear a well :—Do it preferably at the end of hot season, when the level of water is lowest and, if possible, renew the operation every six months. Always ascertain the amount of CO_2 present by lowering a lighted taper before going down into it.

Well-sinking—should be done preferably in soils that are—(*a*) the lowest in level ; (*b*) densely covered with herbage ; (*c*) covered frequently with early morning mists ; (*d*) infested by swarms of insects ; (*e*) situated near the sea or (*f*) at the junction of two long valleys or (*g*) by the side of valley towards the highest hill.

CHAPTER VII.

(A) QUANTITY OF WATER REQUIRED.

Water forms nearly two-thirds of our body ; and besides those used up in forming secretions, we give out, on an average, daily,—by lungs 10 ounces, by skin 20 ounces, by kidneys 50 ounces and by foeces 2 oz., or, an average total of nearly 100 or more ounces of water. With our so-called dry daily food, we take in about two pints of water. To make up for the remainder, we need *drink* two to three pints more water,—roughly half an ounce for each pound of body weight. If however a man is working and living in tropics, he requires to drink very much more water. The following is the **scheduled allowance per head of water** in *temperate climates* :—

I. *For Human Beings* :—

		Gallons per head per diem
(*a*) Household	Fluids as drink	0·33
	Cooking	0·75
	Personal ablution*	5·00
	Utensil and House washing	3·00
	Clothes washing	3·00
	Water closets	5·00
(*b*) Trade and Manufacturing		5·00
(*c*) Municipal	Cleansing Streets	5·00
	Public Baths and fountains	
	Sewer-flushing	
	Extinguishing fire	
	Total	27·08.

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* This is for a daily sponge-bath ; but, in India, where a daily general bath is taken, 30 to 40 gallons of water are necessary.

Or, roughly 30 gallons per head ; this should be the minimum allowance in India in winter ; in summer, a much higher allowance is required.

The allowance per head in gallons in different Municipalities is as follows :—London 35 ; Calcutta 35 ; Edinburgh 38 ; Madras 18 ; Dublin 35 ; Bombay 40 ; Paris 44 ; Rome 220.

II. *In Hospitals*—40 to 50 gallons per head.

III. *For Every Cow or Horse* (drinking, cleaning and washing stables) :—Per Cow—10 gallons ; per Horse—16 gallons.

Dangers of insufficient supply : cleanliness of body, clothes, cooking utensils, house and dinner service suffers ; drains and sewers are not well flushed ; ∴ atmosphere is vitiated ; dust is not allayed, ∴ nuisance is created ; outbreaks of fire go unchecked. Diarrhœa, Typhoid, Typhus, and Relapsing fever, skin and eye diseases increase fearfully.

Waste of water—Some of the water supplied to consumers, runs to *waste* from taps and fittings being leaky and mains leaking from settling of the ground or from fracture of pipes and joints—specially where the supply is constant. WASTE IS DETECTED BY *Deacon's Waste detector* and LOCALIZED by the vibrations heard over nearest house communication pipes, through a stethoscope applied thereto. WATER METERS measure the amount of water consumed—*i. e.*, whether the consumption of water is or is not proportionate to the water-rates paid. They are :—(*a*) *Positive* when they indicate the actual amount supplied ; and (*b*) *Inferential* when the amount of water passed through them has to be inferred from the velocity of flow. TO ECONOMISE DISTRIBUTION OF WATER AND TO PREVENT WASTE, (*a*) a throttle of $\frac{1}{8}''$ to $\frac{1}{16}''$ is inserted into the house communication pipe ; *b*) a screw cock is placed on house pipes where they enter remises ; and (*c*) a drip-trap is attached to the lowest part of the ystem, to empty it during frost.

(B) COMPOSITION OF WATER FROM VARIOUS SOURCES.

	Source of the water.	*Parts in 100,000.*				*Mineral Salts Present.*	*Ammonia.*		*Hardness.*
		Total solids.	Total Hardness.	Chlorine.	N as Nitrates.		Free.	Organic.	
Surface water.	Impervious Rocks, (Reaction—Acid).	Below 10	5	1	0·1	NaCl, $NaCO_3$ $CaCO_3$, MgO.	O	Much	—
	Carboniferous Rocks (Non-calcareous).	Very similar to the above in character.							
	Carboniferous Rocks (Calcareous). ...	Over 10	—	—	—	$CaCO_3$, $CaSO_4$, $MgCO_3$, $MgSO_4$.	—	—	Moderate.
	Lias, Red Sand Stone (New), oolite, lime stone. ...	10-20	10-15	2 Below	0·2 Below	—	—	—	—
	Clay water ...	—	5-20	—	—	—	—	—	Soft.
	Alluvium ...	50-100	—	—	—	Ca & Mg Salts Fe, NaCl, Silica.	—	—	—
Deep water.	Chalk ...	25-50	15-30	2-3	0·3	$CaCO_3$, Fe Phosph., Sulph.			Temporary
	Oolite ...	Very similar to the above in character.							
	Lime stone and Magnesium ditto.	over 25-50	—	—	—	—	—	—	Permanent.
	Dolomite ...	—	—	—	—	$MgCO_3$, $MgSO_4$	—	—	Ditto.
	Green sand ...	100	Variable	4·14	0·3-0·6	—	Much	—	Ditto.
	Red sands ...	100	—	2-6	—	NaCl, CO_3, SO_4, Fe, Ca & $MgCO_3$, SO_4, & Phosph.	—	—	Ditto.
	Selenitic Deposits ...	—	—	—	—	$CaSO_4$	Unfit for use.		—
	Loose Sands ...	6-100	—	High	—	As in red sand	—	—	—
	Lias clay ...	300	Over 20	—	—	Ca & Mg.	—	—	Permanent.

Marsh water—contains a large amount of vegetable organic matter. Water flowing through or near *cemetries* contains ammonium and calcium nitrites and nitrates, fatty acids and much organic matter. Water from *old or closed graveyards* contains less organic matter but more nitrates and chlorides. The water of *coal districts*, if from deep wells, is very pure. Water from *sea coasts* contains chlorides.

(C) STORAGE OF WATER.

This is **necessary** (1) to meet the demands of a locality during drought or (2) as preliminary to filtration of water; (*c*) Also because water undergoes self-purification the larger the storage reservoir and the longer water is retained in it. [But soft waters, and those with ammonia in them, grow chara and nitella, specially, if such waters are held in impounding reservoir.]

I. Storage of Water On Large Scale—

1. **By impounding**—*i. e.* damming the lower end of a valley,—upland surface waters can be stored in big reservoirs in hilly districts. The same precautions as about tanks should be taken in regard to impounding reservoirs. The area should, in addition, be covered by evergreen trees to prevent the soil being washed away.

2. By **Overhead Cistern**—as in Calcutta. The Calcutta Cistern is 320 ft. square and 16 feet deep, with a cubical capacity for 53,000 tons of filtered water, and erected at a height of 90 ft. This is useful for towns that are flat.

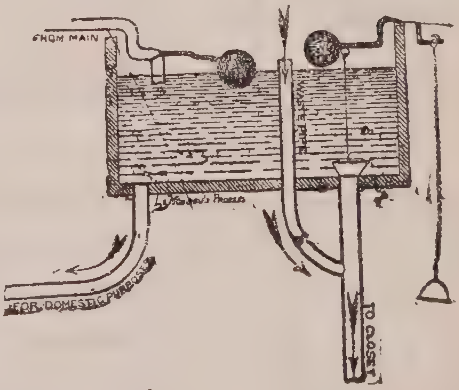
3. By means of **District Service Reservoirs** underground, worked by force pumps. This is suitable for large towns.

4. In **Tanks** and **Ponds.**—in villages.

II. Storage of Water On Small Scale, in households, by means of Cisterns fixed to each house-service pipe. Rain water intended to be drunk, must be first filtered or separated through cloth and then through sand before it can be stored.

A **Cistern** should be *made of* stone-ware, slate or galvanized iron ; in *shape*, it should be a cylinder with an inverted cone as bottom, wherefrom the delivery pipe begins ; the service-pipe, like the overflow pipe, should be soldered into the side of the cistern. [Avoid—iron which rusts ; zinc and lead which poison the water ; galvanized iron vessels, out of which zinc may dissolve, if proper care was not exercised during its manufacture ; avoid, too,—joints repaired with red lead : rather set the joints in hydraulic cement ; wood which rots and harbours fungi and germs ; glazing and enamelling which, if fractured, gives rise to contamination].

It should be PLACED—exposed to light and be covered but ventilated or else water becomes flat, insipid and impure. [It should never be placed in or near water closets, or under floors, landing-floors, stairs. Sewer air, dust, soot, vermins and birds should not be allowed access into it]. It must not be CONNECTED directly with water-closets even if the latter have regulator valve, but may indirectly do so, by supplying the intercepting or waste-prevention cisterns. Its "standing waste" or OVERFLOW PIPE should never be connected with the drain or soil pipe of the house or with a D-trap under a water-closet but "must be carried out into the open air to terminate as a warning for waste of water".



It should be CLEANED out at least once every three months. If it is made of lead, the inside of it should never be scraped during cleaning.

Viability of Typhoid bacilli in Water.—Semple and Greig found that in India b. typhosus lived in urine 3 days and in foeces 4 days. Dr. Houston found that at the end of first week, 99·7 to 99·9% of b. typhosus decreased as the result of storage but their final disappearance from an artificially infected raw river water may not take place until 9 weeks after inoculation. In stored water, b. typhosus ordinarily dies out in 3 or 4 days.

(D).—DISTRIBUTION AND SUPPLY.

This is effected by two means according as the supply is from a natural collection or an artificial one : (1) By **Aqueducts** (either closed or open) over raised masonry arches, with a slight slope towards the outfall (as in Rome). (2) By **Mains** from Reservoirs, the mains leading off into house **Service Pipes.**

THE SCHEME OF WATER-SUPPLY is roughly as follows :—I. Water is first *collected* 5 feet below the lowest summer level, from midstream, away from human habitation, through sieves. II. It is *filtered*, chiefly through sand beds. III. It is *stored* (after filtration) either in over-head or underground reservoirs. Thence, it is led into "*Mains*"—in the former case, by sheer force of gravitation and in the latter case, by district pumping stations. From the "Mains" run "*Distributor*" *pipes* 6″ or 4″ in diameter through every street and lane. To these are attached, on diverticula, Deacon's *meter.* (1) To distributor pipes and at right angles to them are affixed "*Ferrules*" ($\frac{1}{4}''-\frac{1}{2}''$ diameter) whence begin the "*house-service*" pipes. (2) Before each house-service pipe enters premises, a "*house stop cock*" is affixed to it (and the house *meter* too in some cases). The ferrule is provided with a flapping valve that opens out towards the house connexions but prevents reflux of water from house to distributing mains, thereby preventing general contamination through individual houses. The kitchen scullery and upper floors should be supplied direct from the mains.

Householders usually use (*a*) the public pipe direct, by turning the stop cocks ; or (*b*) have reserve cisterns fixed on the topmost storey. Such storage cisterns are best avoided.

Mains—(*a*) should be *made of* iron. (*b*) Their *inside is coated with* Angus Smith solution (=coal-tar pitch+resin+linseed oil) or with vitreous glaze or with magnetic oxide of iron (by Barff's process). (*c*) *Their joints* should be - acute angle, in direction of flow, and never be caulked with tow or gaskin next the interior and then with molten lead. The joints should rather be turned and bored (if small pipes) or pointed with portland cement (if very big pipes). (*d*) They should have *scouring valves* at their dead ends. (*e*) They should be *laid* along inside-walls and at least 3ft. below ground, to be protected from frost and snow). The *temperature of the water* inside them follows the mean air temperature.

Service Pipes are made either of iron or of lead; of these two, iron is to be preferred. Regarding LEAD, its *advantages* are—its ductility, non-rusting and easy joining; its *disadvantages* are—its solubility in certain waters. PLUMBO SOLVENCY * or the power of water to dissolve lead,—is (*a*) *exerted by these waters*: highly oxygenated water, distilled (rain or pure upland water or soft lake water), water containing nitrites and nitrates (=sewage) or chlorides, water from peaty soils (peat water harbouring bacteria that generate humic, ulmic or other acids), water rich in CO_2 (=polluted shallow well) or rich in sulphuric acid (=water from rocks rich in iron pyrites), water that is discharged intermittently or very hot or under pressure of 140 lb. per sq. inch, or water that is mixed with mud and mortar. Bending the lead against its grain, or juxtaposition of other metals increases the plumbo-solvency. (*b*) Water containing gr. $\frac{1}{20}$ of lead to the gallon is unfit for drinking and *lead in water is removable by* charcoal filtration. (*c*) *Plumbo-solvency is inhibited*—by the presence in water of chalk, calcium sulphates, CO_2 or silica (even gr. $\frac{1}{2}$ to 1 gallon) or of alkaline carbonates. Hard water causes a deposit of carbonate of lead which prevents further solution of lead. (*d*) *Plumbo-solvency may be avoided*—by (i) substituting for lead pipes, pipes of bloc tin or (ii) by encasing pipes of block tin in a double coating of asbestos and lead, no undue heat being used in soldering the joints of lead pipe or (iii) by iron pipes protected as above; or (iv) by filtering the water through sand, charcoal or spongy iron.

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* *Plumbo-solvency* is the power that certain waters have of dissolving lead pipes through which they run. *Erosion* of pipes is the action of oxygen dissolved in the water.

IRON pipes* are acted upon by soft water, and by water rich in chlorides. *To prevent* such solvent action, iron pipes are coated with Angus Smith's pitch or Barrf's oxide of iron or hydraulic cement.

Precautions against frost (in cold countries): (1) Lay pipes at least 3 feet under ground. (2) Do not carry pipes along external walls of houses; if however that is unavoidable, then encase them in felt or sawdust. (3) Have a stopcock or valve for cutting off water of premises. (4) When frost is anticipated, run off all water out of the system and shut off supply from the main overnight. (5) Tap may be left running (illegal). (6) Arrange a 48 hours' storage system and take care to protect the pipes supplying boiler. (7) A hinged safety valve (encased in box) may be fitted to every kitchen boiler.

Nature of supply—may be intermittent or continuous. The relative merits and defects of each are :—

Intermittent Supply *vs.*	**Continuous Supply.**
Water has to be stored on the premises, which is liable to become flat and contaminated.	No such obligation exists.
Capacity of stored water may be insufficient, if storage is for many people	Supply is always abundant

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* If *wrought-iron* pipes are used, there should be double-screw joints at suitable places for cleaning rust.

Intermittent Supply (*Contd.*) *vs.*	**Continuous Supply** (*Contd.*)
Risk of same cistern being used to flush closets and supply drinking water	Drain flushed direct from mains by pipes and taps.
Favours corrosion of service pipes, ∴ diminished and turbid water supply	Does not do so.
Does not require pipes and fittings to be very strong	Does require it.
Waste of water inside premises.	More waste.
Higher parts of the town are seldom without water	Higher parts occasionally are.

Dual System of supply *i.e.*, the supply of two kinds of water for different purposes.—(*a*) *People in villages* reserve one public tank or well, as a source of potable water and smaller tanks or wells within the compound of each house, for cleaning and bathing purposes. (*b*) *Municipality* often supplies filtered water for drinking, cooking and other purposes and unfiltered water for flushing water closets, stables, and for gardens, masonry work, out-break of fire etc. It is dangerous to use unfiltered water for drinking, bathing, or washing cooking utensils, as thereby many diseases like cholera may be caused. Both filtered and unfiltered water pipes and mains as well as sewerage pipes and mains have, in several places, to be laid down side by side and in case of filtered water pipe getting fissured, the entire filtered supply gets contaminated.

Hot water supply.—In very cold countries, the householder heats water for his own consumption. There are three ways how he can do it : (*a*) By *worm-boiler* system, its advantages are : that it never freezes so long as there is water in it and it never explodes ; its disadvantages are, that it requires attention and that the supply may run out, if in the kitchen too much water is drawn off. (*b*) By *reserved hot water service*—with a copper or galvanized iron reservoir capable of bearing 20lb pressure to the sq. in. Its disadvantage is that it may boil dry or freeze. (*c*) Double feed *plain boiler*—which is very liable to explosion. [All boilers require periodical cleaning or fur coating occurs inside them.]

Precautions against Fire.—(1) *Inflammable* materials should not be used in building houses or huts. (2) *Cooking house* should if possible be separate from dwelling house. (3) *Gas* and electric fittings should be periodically examined and kept in good order. (4) *Petrol*, *kerosene*, *straw*, *hay* etc. should be stowed away in separate chambers, if possible, detached from the main building. (5) Naked lights should not be allowed ; or, if kept, should be beyond reach of boys. (6) *Garments* of cooks and servants should not be flowing or loose nor made of inflammable material—*e.g.*, flannelette. (7) Sufficient water should be always kept in tank and a few *tubs* filled with water or sand should be always kept handy. (8) *Hosepipe* of some length should also be kept handy.

CHAPTER VIII.

(A) IMPURITIES OF WATER.

Definition—Water is *pure for drinking purposes*, when it is well ærated, free from noxious gases, metallic impurities and excess of mineral ingredients.

Their nature.—In decreasing order of dangerousness, the nature of impurities are—

Bacteria.—specially of the intestinal group (*e. g.*, b. coli, b. enteritidis, b. typhosus etc.) [*Effect* : use of such water produces—dysentery, enteric fever, cholera, goitre (?), infantile diarrhoea].

Organic Matter *(vegetable or animal)*—of a decomposable character : *e.g.*, carcass, urine, foeces etc.—Their presence is detected by the presence, in water, of sodium chloride ammonia, nitrates (specially ammonium nitrate), nitrites, sulphates and phosphates. *Effects* of drinking organically polluted water are : (1) Dyspepsia, diarrhœa. (2) Tænia solium, tænia echinococcus, bothriocephalus latus, ascaris lumbricoides, oxyuris vermicularis, filaria sanguinis hominis. (3) Bilharzia hæmatobia, tricocephalus dispar, distoma hepaticum, anchylostoma duodenale and filaria dracunculus. (4) Leeches. [(5) Anthrax, hog-cholera and glanders—in cases of animals.]

Note that—(1) Not only contaminated water gives rise to disease but that vegetable salads grown on contaminated soil may give rise to intestinal diseases ; and (2) that outbreaks of intestinal disorder are characterized by sudden origin and rapid spread in a locality near about the source of water supply.

Hardness—Effects of drinking hard water for a long time are—dyspepsia, calculi (?) .

Suspended matter—dust, soot, colouring matter, earth etc. [*Effect* :—Diarrhoea].

Metallic contamination.—Calcium sulphate, chlorides and nitrates produce dyspepsia and diarrhoea ; magnesium salts, goitre ; iron, constipation ; lead, paralysis ; fine mica scales, muco-enteritis or hill diarrhoea etc.

Sources of Impurities in water are :

Source of water.	When, where or how imbibed.	Nature of the impurities.
Distilled ...	During storage or distribution	Dissolves out Zn, Pb, Cu.

Rain ...	(1) Falling through space. (2) Falling over Roofs.	(1) C, SO_2, SO_3, bacteria, fungi, pollens, dust. (2) Soot, dust, decomposing vegetables, animal excreta.
Upland surface ...	1. During passage. 2. During storage.	1. Acid from peat, sewage, animal droppings. 2. Algæ and other microorganisms. Pb or Zn (acid corrosion.)
River ...	1. By percolation. 2. By direct pollution.	1. Sewage or organic matter from trenching or burial ground. 2. Sewage, bacilli of intestinal group, trade refuse.
Spring ...	By percolation.	Minerals, organic matter & bacteria from nearest cess pits &c.
Well ...	1. Percolation. 2. At source.	1. Organic and bacterial filth. 2. Chalk, iron etc.
Tank ...	1. Percolation. 2. By surface pollution.	1. Organic and bacterial filth. 2. Decomposing vegetables, animal and human filth of all sorts.
Stored in cisterns ...	During storage.	Pb, Zn, etc. Algæ, small animals, microorganisms. Dead leaves, dust, soot.
Pipes and Mains ...	1. During intermittent supply. 2. Owing to sinking or damage	1. Pb, Zn. 2. Contamination by sewage or unfiltered water pipes—whichever be near.

As a rule, it is safe in the tropics, to assume every unknown water to be impure and to purify it before use. Water may be fouled (1) At the *source*, (2) During *storage*—(3) During *transit* to reservoirs or (4) During *distribution*.

At the source :—(1) By Ablution, (2) washing soiled linen, cooking utensils &c. ; (3) washing and watering cattle or allowing cattle to graze by the source of supply ; (3) using temporarily dry beds of rivers for easing oneself. (4) Throwing dead bodies or portions of them into the water. (5) Discharging town drain or septic tank effluent, trade sullage or other filthy liquids into the water. (6) Passage of water through undesirable geographical strata. **During distribution.** Water may be distributed through (*a*) *Lead pipes* causing lead poisoning. (*b*) *Leaky pipes* or pipes not laid on properly or laid too close to leaky sewer pipes—imbibing organic filth. (*a*) *Water carts* which are not air tight, which are not kept clean, into which the unclean drivers may descend for purposes of cleaning or which are not parked in clean places in cleanly condition. (*d*) *Masaks*—or leathern water bags. These are never clean and can never be kept clean; they are handled very dirtily by people who themselves are dirty. (*e*) *Pots and pitchers*—See next item. **During Storage.**—(*a*) In unglazed and narrow-mouthed earthen pots called *surais*; they are not kept covered. These unglazed earthen pots should be changed every two months or baked over an oven occasionally to destroy the slime that forms inside. It is safe to have glazed pots with covers in which alone water should be stored. Only water, that has been sterilized by boiling should be poured into 'surais' while boiling hot. If required to be cooled, *ice* should never be put into the water but a vessel containing water may be cooled by placing it on crushed ice. (*b*) *Slate* or *Galvanized iron* vessels are costly and seldom found in India. *c*) *Copper and brass* vessels are not only safe, because they can be cleaned, but probably have a purifying effect on water. Water in them should be renewed daily and the inside and outside of them should be daily cleaned, specially, if they are metallic. They should be always kept covered. (*d*) *Chowbachhas* or uncovered masonry tanks—are seldom used as collections of drinking water. Water from them is however used for washing the mouth and hands. Hence, they should be well cemented, free from moss-growth, and situated away from cess pits and latrines. They should be kept well covered and there should be but one bucket set apart for drawing water from them. That bucket should be kept scrupulously clean and on the side of the chowbachha and not beside it. The broom-stick used for cleaning floors should never be dipped into the chowbachhas to cleanse their sides and bottom and the water in them should be renewed every second or third day.

Classification of waters: (1) *According to their impurities* :—

Wholesome	1. Distilled water (aerated)	Palatable.
	2. Rain water (in villages)	
	3. Main spring water	
	4. Deep well water	
	5. Upland surface Water	
Suspicious	6. Stored Rain Water	Moderately palatable.
	7. Surface Water from cultivated Lands.	
	8. Land springs.	
Dangerous	9. River water to which sewage gains access.	Palatable.
	10. Shallow well water	
	11. Tank water promiscuously used.	

2. *According to Softness* (in descending order): Rain water, boiled water, upland surface water, surface water from cultivated land, river water and polluted well water, spring water, deep well water, shallow well water.

(B) WATER PURIFICATION.

Necessity.—As drinking impure water causes diseases, we require to purify it to save ourselves from diseases.

What it aims at.—It aims at removal of (1) excessive *hardness*, (2) *floating* particulate matter, (3) dissolved *organic* matter and, most important of all, (4) *germs* of disease.

The processes whereby water is purified are—

Nature	*The Process*	*Remove what*
Physical	...Boiling, Distillation	...Germs, hardness, solids.
Mechanical	...Filtration	...Solid particles.
Chemical	...Precipitation	... Ditto.
	Germicidal action	... Germs.

I. **Natural Means of Purification** :—Natural or self-purification occurs in rivers* &c. ; but unfortunately, natural purification is never complete because it seeks to remove chiefly two things, *viz.*,

1. Particulate and organic impurities—which are got rid of, successively by—*(a) Dilution* of the mass of organic matter by the large and rapidly moving mass of water :—the purer the quality and the greater the volume of the water, the more efficient is the dilution. *(b) Sedimentation* of the particles—down to the bed of the river, when its current is sluggish. *(c) Oxygenation* of the oxidisable portions of it—by oxygen existing in running waters (specially where they run over rapids and weirs), in water-plants, and in minute aquatic animals (infusoria, anguillulidæ, entomostraca etc). *(d) Feeding*—by aquatic animals. *(e) Fermentation,—i e.*, breaking up into simpler bodies. This is specially seen if water is very much polluted and the weather is hot.

2. Bacteria—(B. coli, enteritidis, sporogenes, comma, typhosus, streptococci, &c.). These are disposed of thus : —(*a*) some get *degenerated* and attenuated, being rendered comparatively harmless ; (*b*) others are *caught and thrown down* to the bottom by sedimentation ; (*c*) still others *die quickly*,—specially if the water contains actively growing non-pathogenic organisms. [They do not die out soon, if the water is free from other organisms and contains instead pabulum for the bacteria, as in deep well waters .

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* Bacteriologist Hankin remarks :—"The water of the Ganges and Jumna is hostile to the growth of cholera microbe, not only owing to the absence of food materials but also owing to the actual presence of an antiseptic."

II. Summary of artificial means of purification :—

The Impurities.	On *Large* Scale (*A*) (*Public*).	(*B*) On *Small* Scale (*Domestic*).
Bacilli ...	(1) Chlorination. (2) Ozonization. (3) Treatment by Ultra-violet rays.	*Boiling*, Sterilization, Distillation. *Chemical Treatment* : Br, O_3, $Ca(HO)_2$, K_2MnO_4, Cl, Bleaching powder, Na HSO_4, Na-iodide-iodate, Nesfield's tablets, Cu. *Filters* : Pasteur-Chamberland, Berkefeld, Porcelaine D' Amiante.
Dissolved *Organic* Matter ...	(1) *Filter* : Sand bed. (2) *Filter* of Iron (spongy, metallic, magnetic carbide, polarite.)	1. *Filter*: Animal charcoal; asbestos + charcoal ; silicated carbon ; manganous carbon, 2. *Filter* : Spongy, Bischoff's, magnetic carbide of iron, polarite, Carferal. 3. Alum, strychnos potatorum.
Hardness ...	(1) Boiling. (2) Lime ; Lime + Na ; Lime + Na + Alum.	1. *Boiling.* 2. *Chemical* : Lime, Soda Ash. 3. Alum.

(A) DOMESTIC PURIFICATION.

To Kill Germs—Apply heat, chemicals or filters :—

I. By application of Heat.—Heat aims at one of these :—

(1) STERILIZATION—that is, making germ-free, by raising its temperature to 212°F, *without producing actual ebullition* ; for heat to render water absolutely free from germs (including spores), water should be sterilized for at least 3 or 4 successive days, for at least half an hour daily. Usually, we refer to water free from germs by the expressions—'*pure*' or '*germ-free*' rather than 'sterilized'.

(2) BOILING—*i. e.*, heating with ebullition, which renders water practically free from germs (but not their spores) and kills all living matters. It disengages CO_2 and other dissolved gases and precipitates calcium carbonate (thereby removing

temporary hardness). ['*Waterman-Forbes*' is a portable apparatus for this purpose.]

(3) DISTILLATION.—This frees water from germs and foreign ingredients and gives the purest form of soft water, provided (*a*) the first portion of the distillate is thrown away and (*b*) the distilled water is not kept in copper, iron, lead or zinc vessels, but rather in sterile, clean, silver-lined, bloc-tin or enamelled vessels, well covered. To render it palatable and to destroy its flatness, run it through a fine *sterile* sieve, in divided streams, to enable it to absorb CO_2 from air. It is expensive.

II. By Treatment by Chemicals : Any of these is used :—

1. BROMINE (Schumberg's process).—To each litre (35·196 oz) of water add 0·06 grain each of bromine and pot. bromide and the typhoid and cholera germs disappear. Remove the excess of bromine by 7·2 grammes sodium sulphite and 3 grammes of anhydrous sodium carbonate.

2. CALCIUM PEROXIDE, $Ca(OH)_2$ 3. OZONE, O_3.

4. POT. PERMANGANATE.—One part of permanganate is first dissolved in pure water, to which 7 parts of sodium carbonate and slaked lime have been added. Add a sufficiency of this mixture to the water to be purified that will make and keep the water pink for at least half an hour ; on this basis, an ordinary well requires 4 oz. of the crystals. This treatment of the water should be followed by alum sedimentation and filtration, or treatment with anhydrous ferrous sulphate 8 parts.

5. CHLORINE—as hypochlorite or as hypochlorous acid.

6. BLEACHING POWDER, $CaCl_2 + Ca(ClO)_2$. One and a half grains of bleaching powder, with half a grain of sodium bicarbonate put into 1 pint of water sterilize it in 15 minutes. To free the water from chlorine, add gr. ¼ of sodium sulphite.

7. ACID SODIUM BISULPHATE (Parkes and Rideal).—1 gramme to 1 pint of water for 15 minutes kills b. typhosus, dysentery and cholera. It makes the water a little acid to the taste. 8. LIME—1 oz to 1 cubic foot of water.

9. IODINE.—Into 1 litre of water pour tartaric acid, pot. and sodium iodide, and after 10 minutes, sodium hyposulphite. This mixture kills bacilli coli, cholera and typhosus.

10. IODIDE IODATE OF SODA (Nesfield).—Two grains of this + 2 gr. citric acid in 4 gallons of water, kill in a few minutes cholera and typhoid germs. [The free iodine is removed by sodium hyposulphite]. Vellard uses tartaric acid, sodium hyposulphite, potassium and sodium iodide.

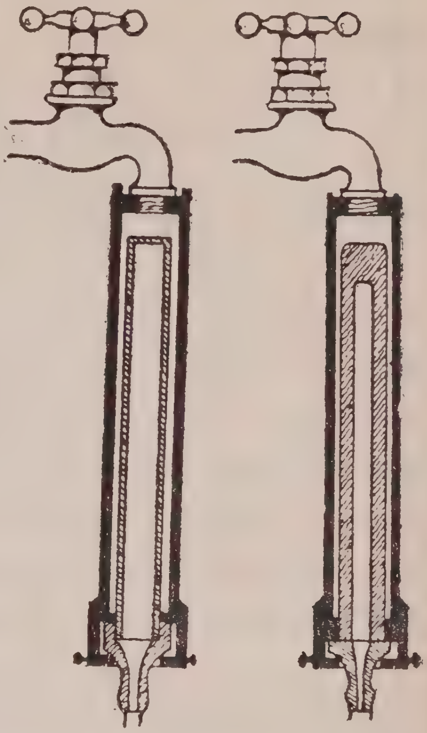
11. COPPER : (*a*) *The Sulphate* :—10 ℔ to million gallons of water. The water is not safe for drinking till at least after 24 hours. Filtration after a week through polarite or towels at once removes the copper. (*b*) *The metal*—in strips, if kept in water for 12 hours, kills typhoid germs. Remember the risk of poisoning by use of this water by susceptible patients. Chara, nitella, algæ and other low forms of vegetation disappear quickly.

III. By High pressure Filters :

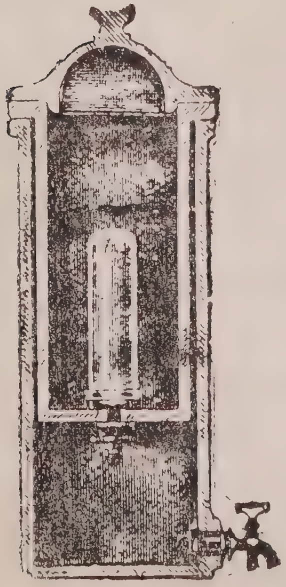
Object : Filters aim at removing (*a*) fine suspended mineral and organic matters, (*b*) low forms of animal and vegetable life and (*c*) bacteria. Removal of these has the effect of rendering the water clear, tasteless and odourless. **To be efficient**, filters require —(*a*) preliminary storage and sedimentation of the water, (*b*) constant and scrupulous cleanliness of filters themselves.

Varieties of Domestic Filters : (*a*) *High pressure* filters—*i.e.* those meant to be attached to water-taps, whose pressure drives the water in ; and (*b*) *Low pressure* filters—where water glides down by its own weight. The high-pressure ones are reliable, the low-pressure ones are dangerous. We describe here only the former. Remember that no filter with the slightest crack can be safe.

1. Pasteur-Chamberland.—*Parts*:—Hollow cylinder (called candles or bougies) of fine-grained, unglazed porcelain (kaolin) enclosed in a metal jacket; between the jacket and cylinder is a space. The cylinder is closed above and ends in a nozzle. It can be screwed on to taps, water passing up into these cylinders and coming out sterile at the top of these tubes. *Merit*:—Frees water of bacilli and their spores and of all suspended matter. *Disadvantages.*—Requires to be worked under pressures; does not alter chemical composition of water; and gets frequently clogged in tropical muddy water; requires frequent brushing to clean it; or else arrested microorganisms grow into it.



2. Berkefeld Filter.—*Parts*:—Hollow cylinder made up of siliceous or infusorial earth; it too may be screwed on to taps but no pressure is necessary. *Merits*—Same as of Pasteur-Chamberland; more perfectly cleaned and more rapid in action. *Disadvantages*—Is more fragile than Pasteur-Chamberland; requires cleaning and sterilization every third day; soon wears thin, (∴ becomes unreliable) and requires the water to be freed from mud and other suspended impurities before the water can be filtered by it.



3. PORCELAINE D'AMIANTE : *Parts* are made of clay mixed with finely powdered asbestos. *Merit*: It is the best sterilizer. *Disadvantage* : it is very slow.

IV. By Ultra Violet Rays.—See infra.

To remove organic and suspended impurities.

No kind of filter is safe for any length of time, nor does any filter, however reliable, dispense with *frequent attention.* Every filter, if neglected, while giving a false sense of security to its idle and complacent user, becomes a potent source of pollution of water by bacilli and by putrescent organic matter. All low-pressure and rapid filters and filters with the slightest crack—are unreliable so far as rendering the water germ-free is concerned.

I. Charcoal Filter : Varieties are :—

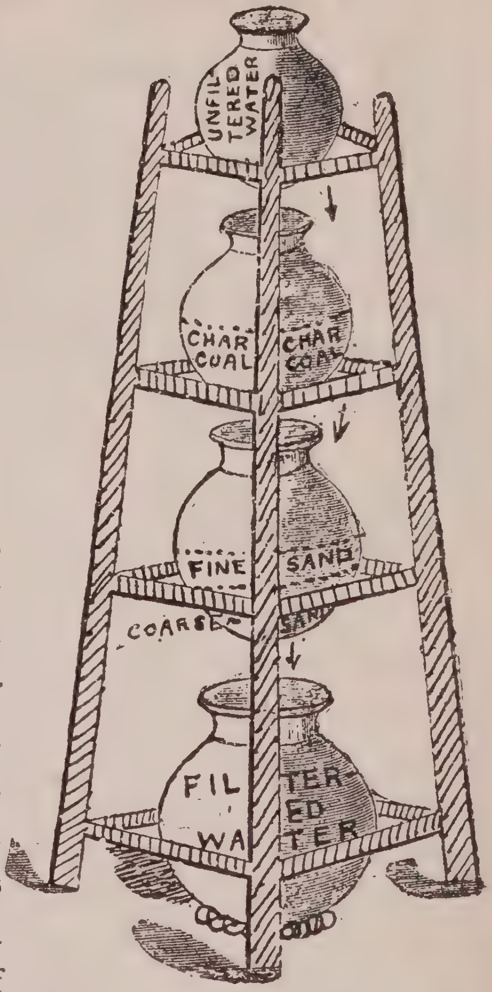
1. ANIMAL CHARCOAL : (*a*) FINELY POWDERED.—*Merits* : Bleaches colouring matter and oxidises to some extent organic impurities. *Disadvantages* : Action is short-lived, unless frequently renewed ; cannot arrest passage of living disease-germs ; imparts to the water $Ca_3(PO_4)_2$ which latter favours growth of living organism in the water. "*Requires more care and attention than any domestic filter-.*" (*b*) BLOCK CHARCOAL Same action as above ; it can avert lead-poisoning provided its surface is kept clean by frequent scrubbing.

2. ANIMAL CHARCOAL LAID OVER ASBESTOS CLOTH spread over a perforated porcelain cone. (Maignen's Filtre Rapide).

3. SILICATED OR MANGANOUS CARBON=Blocks of carbon mixed with silica or manganese. *Merits :* They don't yield so much phosphates to water. *Disadvantages :* They get clogged (and therefore become unsafe) and have to be frequently

brushed, and boiled every three months in sulphuric acid or pot. permanganate or heated to dull red heat.

4. 'WOOD' CHARCOAL & SAND FILTER—used throughout rural Bengal. The arrangement is as follows : On a wooden or bamboo stand are stood, one below the other, and at least six inches apart from each other, four unglazed earthen pitchers, the first three of which have a hole at the bottom lightly plugged with straw or cotton and of which, the—*First Pitcher*—contains the strained and sedimented water ; *Second Pitcher*—contains finely powdered wood charcoal (renewed weekly) ; *Third Pitcher*—contains a layer of fine sand over a layer of gravel (cleaned and dried once a month) and the *Fourth Pitcher*—receives the filtered, bleached and aerated water. This water, if sterilized before using, furnishes a fairly safe water.



II. Chemical Treatment (without filters) :—

ALUM (free from acid and iron) :—2 to 6 gr. to 1 gallon will precipitate suspended matters along with the chalk held in solution. It has no effect on pathogenic germs and on soft waters. The addition of 5 grains of lime or of a little calcium chloride and sodium carbonate is necessary in such cases.

2. PERCHLORIDE OF IRON—is used instead of alum; but it leaves chlorides in solution.

3. NIRMALI (Strychnos potatorum), "clearing nut."—Its seed is rubbed in the middle of the vessel and after a while the entire mud settles down, leaving clear water above it.

To remove Hardness, have recourse to—

(1) BOILING (2) ALUM treatment (3) LIME WATER treatment.—(1 oz. lime to 1 c. ft. of water).

B. PUBLIC PURIFICATION.

To kill Germs. The methods in use are three :—

1. Chlorination = treatment of water by hypochlorite of calcium. *Merits* :—cheapness; after half an hour, the water and the pipes and mains are rendered free from and somewhat proof against, b. typhosus. *Disadvantages :* Water has to be previously purified physically through beds of sand and polarite and chemically; and it imparts disagreeable odour and taste to the water (1 to 2 parts per million, of available Cl) [This is removed by treatment by bisulphite of soda or passing through vegetable charcoal]. *Applicable to*—Sewage-contaminated river-waters.

2. Ozonization (*De Frise process*) = treatment of water with 40% ozonized air. *Merits*—Destroys microorganisms but not their spores; reduces the organic impurities. *Disadvantages* : costly; complicated as to dosage; gives disagreeable taste to water, the water requiring to be previously filtered; it leaves untouched the chlorides, sulphates and carbonates and increases free oxygen and nitrates.

3. Ultra-violet Rays Treatment—as produced in the quartz mercury vapour lamp. *Merits*—kills all germs quickly. *Disadvantages* :—Costly, complicated, requires that the water should be absolutely clear and bright to start with.

To remove organic matter and suspended impurities two methods are in use :—

I. "Mineral" Filtration :

1. Spongy Iron (Bischoff's) :—This is *composed of* four layers—from above downwards—of spongy iron-ore, pyrolusite (which acts as an oxidiser), sand (which removes the iron taken up by the water) and asbestos cloth. *Merits :* Imparts only a little iron to water, which is easily removable by filtration through sand ; separates lead from water ; the filtered water can be stored in it for some time ; retains its properties long. *Disadvantages* : Requires periodical renewal. Intermittent action takes place in the iron.

2. Magnetic carbide of Iron.
3. Polarite ($=MgO + Fe_2\ CO_3$ } The former partakes of much of the character of spongy iron. *Advantages :* These don't require disturbance or renewal (∴ time and labour are saved) and by intermittent action, water is well aerated.

4. Scrap Iron (*Anderson's Process*) : A shower of scrap iron is sent through water which is then exposed to air, when the iron in it is precipitated as an oxide and this last is filtered through sand.

5. Carferal = *car*bon + *fer*rum + c*lay*. *Advantages :*—This is a good oxidiser and does not yield to the water any thing favourable to organic life. *Disadvantages :*—Its lasting powers are inferior to those of spongy and magnetic carbide of iron.

6. Alumino ferric—1 to 2 gr. per gallon reduces the turbidity by 75% in 24 hours.

II. **Sand Filter beds**.—Collect the water as previously directed (p. 87) ;—avoid collecting during flood tide. Settle—the water so as to secure sedimentation, for nearly thirty hours ; this reduces the hardness, the amount of suspended matter, and the ammoniacal nitrogen, and, if the storage extends to four weeks, 99% of bacteria die. Storage of nine weeks renders the water germ-free. Sudden breakdown of such filters, therefore, is not disastrous. From this settling tank, lead about two feet deep water to the FILTER BED.—Each bed should not exceed one acre in area, should have separate filter wells for sampling and should CONSIST from above downwards, of—(*a*) Fine sand—3 feet deep (*b*) Fine Gravel* (*c*) Coarse Gravel—3 to 8 feet deep; it is provided with two VENTS—(*a*) from deeper layer gravel to above water level, to allow of escape of imprisoned air; and (*b*) from bottom—leading the filtered water to—the central FILTERED WATER WELL.—This had better be kept well covered.

Remarks regarding sand Filtering :

1. ORGANICALLY POLLUTED water does not become potable, even after filtration. "There is no river in the United Kingdom long enough to effect the destruction of sewage by oxidation."

2. The Filter Beds—require to be REMOVED periodically, —say once every 2 months by—(*a*) Scraping off the upper layer ⅛ to ¼ inch, washing them off in a jet of water and drying the sand; the minimum limit is two inches, below which the sand must never be scraped (*b*) While replacing the sand, do not use the water passed through it for at least the first two days.

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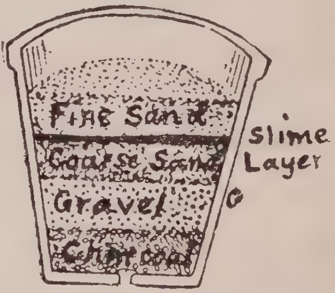
* In the case of "Pressure" filters, the successive layers are: (*a*) Fine sand and (*b*) Polarite (magnetic oxide of iron), the water being previously treated with alum (gr. 2 per gallon). The Malabar Hill filter bed contains—(*a*) large shingle (1 " mesh)—3," (*b*) Fine shingle (½" mesh)—3", (*c*) White river sand—12", (*d*) Bassaltic —12".

[The frequency of scraping depends on—(*a*) whether the bed is covered or uncovered, the latter growing the algæ slowly, (*b*) the efficiency of the preliminary precipitation of the water, (*c*) the size of the sand grains, (*d*) the rate of filtration and (*c*) the maximum loss of head allowed. Intermittent and shallow filters require more frequent scraping than continuous and deep ones].

3. Filters used continuously require less frequent change of sand than those used intermittently. The germs are found chiefly in the first inch of sand. Water containing 100 germs to the cubic centimetre is impure.

4. Efficiency depends on the formation of a thin *slimy* film over the surface, being *made up of*—green and blue algae, diatoms, zooglea and bacteria. *This acts as* a dialyser or interceptor of bacteria, from third day, when over 80% are here arrested, out of which, 55% are in the upper ¼ inch of fine sand ; sand filters not only arrest germs but also oxidise the ammonia and nitrites present in the water. *Danger of slimy layer*—is that this layer tends to grow down deeper into the bed and thereby contaminate the water. This *slimy layer is broken up by*—frost or too great a rush of water, or by water rich in insects and vegetable growths. Hence, now-a-days, filter beds are filled from below, very cautiously. Fine sand forms this sediment-layer more quickly and more efficiently than coarse sand and is, on that account, rather slow and expensive, for it clogs.



5. The disadvantages of sand filters are (*a*) the process is very slow, (*b*) it is expensive in cleaning and (*c*) it requires some time after cleaning before it can be used.

6. Prof. Koch's dicta of efficiency of Sand Filters :—(*a*) There should be a film of '*slime*' on top of filter beds, which should not be disturbed unless too thick and certainly

never during filtering process. (*b*) The *thickness of sand* should be at least 30 cm. (=11·8 inches). (*c*) The *rate of downward percolation* must not exceed 100 mm. (=3·94 inches) in an hour (=20 million gallons per acre daily).

7. Filters should be tested daily.

EXAMINATION OF WATER.

Absolutely pure water—free from mineral, organic or bacterial impurities—is practically not found. All that we want to know from an examination are, freedom from—living disease *germs*, *metallic* contamination and unpurified *organic* matter. To be sure of results, analyses should be undertaken frequently and compared with analyses of waters in the immediate neighbourhood. The *physical* examination is often deceptive as to fitness of water; the *microscopic* examination warns us about the actual sources of pollution and germs present; the *chemical* tells us of the amount of organic (fœcal) and metallic contamination; while the *bacterioscopic* tells us of the nature and source of the germs present. And an examination to be reliable must include all these. Generally speaking, water that is chemically *pure*, is likely to be bacteriologically pure too and *vice versa*; also, if a sample is chemically *impure markedly*, it is likely to be so bacteriologically too. Waters *intermediate chemically* between these two, may be bacteriologically pure but are liable at any stage to harbour and flourish germs.

How to Collect Samples: (1) *For Chemical Examination*, use a new Winchester quart bottle with a sterile tight-fitting glass stopper;—the collection is made from stand-posts, without immersing the bottle. (2) *For Bacteriologic Examination*,—use sealed and sterile flasks of Pasteur, which suck in water at the end nipped off under water. (3) If *Collecting from taps*, let some water run to waste before collecting; but if water has to be tested for presence of lead or iron, do not let a drop run to waste. (4) If *collecting from Midstream* or from some depth of water, use Dr. Thresh's bottle, keep bottle stoppered while immersing it and open stopper where actually water is to be collected. Always prefer the windward side and away from the banks.

Before use, wash the bottles and stoppers in strong acids, rinsing subsequently in ordinary clean water and finally twice in the water to be sampled. Do not completely fill any bottle, but keep a little air in, and, after putting back the stopper, do not use grease or sealing wax but cover the stopper with india-rubber or clean wash-leather or linen ; finally seal and keep the bottle in cool, dark place. But do not delay in sending it to destination or examining it, as delay may vitiate results by allowing time for growth of germs &c. The bottle should be properly labelled for identification and accompanied by a letter stating : (*a*) Source (tank, tap &c.) (*b*) Geological strata through which the well has been sunk and geological formations of the country. (*c*) Meteorological conditions (amount and last date of rain-fall &c.). (*d*) History of illness in any employe and of washing soiled linen &c. in the water. (*e*) Details of any houses or villages on the catchment area and of any other sources of pollution. (*f*) Manner of storing and distributing the water.

I. PHYSICAL EXAMINATION.

Colour—As seen down through a colourless glass tube, at least 2 ft. deep, held against a white ground, water is—(*a*) *Blue grey*—when it is pure (*b*) *Green*—when contaminated by vegetables (*c*) *Yellow* or *Light Brown*—when contaminated by sewage, peat or iron.

Clearness after shaking :—if sample is (*a*) *Clear* and sparkling —it is pure ; (*b*) *Hazy*—contaminated. [If turbidity is *blackish* =peat or vegetables ; *brown*=sewage ; and *whitish yellow*, clay or sand.] Polluted shallow well water is also clear and sparkling !

Taste : If the taste is—(*a*) *Disagreeable*=pollution, in which the solids are not perfectly dissolved, but only partly so. (*b*) *Flat* which means that the water is non-ærated. (*c*) *Chalybeate i. e.*, the water contains iron.

Smell—as evolved after gently warming the water or after keeping it in a warm place for some days—will tell us if there is H_2S or putrefaction going on.

II. MICROSCOPICAL EXAMINATION.

(After centrifugalizing or standing the sample of water in a conical glass).

Presence of—(1) Fibres of cotton, wool, linen, macerated papers, human hairs, yellow globular masses—indicate **human contamination** (sewage probably). (2) Squamous epithelial cells, striped muscle fibres (=undigested meat), yellow elastic tissue, spiral cells—indicate **human fœces.** (3) Spiral cells of cabbages, cauliflower, starch granules=**human fœces.** (4) Intestinal group of bacilli (amœbae, Shiga's bacilli, comma bacilli &c.) indicate—**human fœces.** (5) Bacteria (micrococci, bacilli, vibriones), amœbæ, infusoria—indicate **ancient organic** contamination. (6) Fungi, moulds, algæ, diatoms, desmids, confervæ with or without higher organisms=**vegetable contamination.**

III. BACTERIOSCOPIC EXAMINATION.

Steps: (1) Mix 1 cc. of water with a test-tube-ful of liquefied sterilized agar or gelatine over a glass plate and cover it by a bell-jar to prevent entrance of atmospheric spores and set the whole thing in an incubator. After 48 or more hours, "colonies" dot over the plate, from development of the spores or germs. They can be differentiated by their characteristic colour, mode of growth, appearance, size and the liquefaction of the gelatine. Then use the microscope and find out which colony contains fungi, bacteria or moulds.

Significance (1) Presence of even **non-pathogenic organisms** points to contamination by organic matter, ammonia, nitrates, phosphates. (2) "A water which gives *no* indication of the presence of b. coli communis in 10 cc. of water examined, nor of streptococci in 50 cc, nor of the spores of b. enteritidis sporogenes in 500 cc. is satisfactory." (3) Presence in water of b. comma, b. typhosus, b. coli communis, streptococci, b. enteritidis sporogenes, b. acidi lactici, indicates animal excrementitious contamination. (4) As a rule, the presence of **B. Coli** indicates recent pollution by animal excrementa and its presence or disappearance is a fairly safe indicator of presence or absence respectively of other intestinal bacilli. (5) The standards of purity suggested are :—

	B. Coli as evidence of recent contamination. (Number per cc.)	*Bacteria generally.* (Number per cc.)	
Pure	... O in less than 100 cc	0 to 10	in one c. c. of water.
Good	... O in ” ” 10 cc	100 to 200	
Passable	... O in ” ” 1 cc	200 to 500	
Bad	... O in ” ” ·1 cc	500 to 1000	

Obviously, such a standard is not to be exclusively relied upon. Koch allows a maximum bacterial count of 100 bacteria per cc of water as test of efficiency of a filter. A numerical count is of value as a standard for comparison with subsequent counts.

Parietti's method for detecting Eberth's **Typhoid bacilli**: Add 3, 6 or 9 drops of a 5% solution of carbolic acid in water and 0·4% solution of HCl to the gelatine or agar. To these add the water to be examined and keep the thing at 42·C.

IV. CHEMICAL TESTS.

Hardness.—Make *Clarke's Soap Solution* as follows: 17 grammes castile soap + methylated spirit (35%) 4 parts + distilled water (6 parts). This solution is graduated with 1·11 gramme of $Ca\,Cl_2$ to 1 litre aq. destil., so that 1 cc = 1 mgrm of $Ca\,CO_3$ (or 1 gr. to 1 gallon). To estimate (*a*) *Total hardness*: To 100 cc of water add the above soap solution till a lather is formed, which is permanent for 5 minutes. Total hardness per 100,000 parts = number of cc of soap solution used minus 1. (*b*) *Permanent Hardness*: Boil 150 cc of water for 20 minutes and when cooled, add aq. destil. to make up to 150 cc; filter off 100 cc and then apply the test, as above. (*c*) *Temporary Hardness.* = total minus permanent hardness.

Total Solids: Determined by weighing the residue left after first evaporating to dryness in a weighed platinum dish 50 cc of water and then heating the residue to redness over a flame (to drive off the organic and volatile matters).

Chlorine.—*Its presence indicates* (1) nearness of source of water to sea or to certain geological strata bearing chlorides of calcium and sodium; (2) proximity to alkali works and mines; (3) contamination by liquid excreta of man and animals. *Test*: To 50 cc of water, on a white porcelain dish, add firstly, drops of yellow chromate of potash and then silver nitrate solution (4·788 grammes per litre). Now, 1 cc of this solution precipitates 1 mgm. of Cl = 1·5 mgm of NaCl. Wanklyn rejects samples containing 5 to 10 gr. per gallon, while Thresh objects when it is more than 50 per gallon.

Nitrates :—*Nitrogen exists in water as* free nitrogen, nitrites, nitrates, ammonia, and organic matter. Nitrogenous organic matter when oxidized, forms ammonia; this when oxidized produces nitrous and nitric acids. The soil contains nitrates which it can part to pure water passing through it. On the other hand, very bad waters may be partially deprived of their nitrates by impurities of the soil. *Significance of Presence* :—If a sample of water shows—(*a*) Nitrites, nitrates, ammonia and chlorides, it suggests recent animal organic contamination; (*b*) Nitrates, very little ammonia, no nitrites—it means impregnation with organic animal matter; (*c*) Large amount of nitric acid with little organic matter —it means old contamination. Presence of Nitrates (*a*) in water of deep wells or springs = pollution with remote sewage or present contamination with partially purified sewage. (*b*) In case of shallow wells = recent soakage of partially purified sewage or animal refuse—owing to too much drawing of water. *Tests* : (1) (Nesslerising): Evaporate to dryness in a platinum dish 10 cc of water. To residue add 3 cc of a solution of $H_2 SO_4$ and phenol + HCl (m ij) and heat it over a watch bath 3 minutes. Pour it into a Nessler glass and neutralise it with KOH. Fill up to 50 cc with aq. destil = formation of picric acid. Compare the depth of yellow colour produced with that of a similarly produced test solution, containing 1 mgm of KNO_3 in each cc. [To express in terms of N as Nitrates, multiply result by 0·14]. (2) To the residue after evaporating the water add $H_2 SO_4$ and brucine = pink coloration.

Nitrites :—*Significance* : (*a*) fresh organic matter is undergoing oxidation; (*b*) nitrates have become somewhat deoxydized; (*c*) recent contamination with partially oxidized sewage, (∴ dangerous, specially in the case of shallow wells and rivers, unless it is known that the water is from peaty area.) [Nitrites are not present in raw sewage.] *Test* : To water add $H_2 SO_4$ and metaphenylinediamine = yellow colour.

Phosphates.—*Significance* : Sewage contamination if present in any marked quantity. *Test* : Boil the water, and to it add HNO_3+ ammonium molybdate=yellow colour.

Ammonia : *Derived chiefly from*—urine and other animal matters, specially if co-existent with chlorine. If co-existent with nitrate=old organic contamination. *Forms in which obtained* : (1) Free or Saline ammonia=that which is obtained by distilling sewage, manure or other albuminous things rich in it. (2) Organic or albuminoid ammonia=ammonia obtained by acting on albuminous matter by alkaline solution of pot permanganate. "If the albuminoid ammonia exceeds ·005 part per 100,000, the free ammonia should not be above this amount ; but if the former is much below this, then much free ammonia may not signify danger. Conversely, the albuminoid ammonia may reach up to 0·01 per 100,000, if the free ammonia is much below ·005 and if there is practically no free ammonia, *i.e.*, below ·002, then the albuminoid ammonia may be allowed to considerably exceed ·01, as it does in many peaty water, which are safely used for drinking purposes." *Significance* : (1) Animal pollution with urine which has not been fully oxidised, or albuminous matter. Excess of ammonia in water often means excessive amount of organic matter too. (2) Storage of water in vessel of Fe, Zn, Pb &c. (3) Percolation of water through layers of chalk and greensand. *Tests* : (1) Free Ammonia : Distil 150 cc of the water in a boiling flask connected with a Graham's condenser ; take 50 cc of distillate and add to it 2 cc Nessler's Solution : compare the yellow colour produced with that obtained from a measured quantity of a standard solution of NH_4 Cl (each cc of which contains 0·01 mgm of NH_3). (2) Albuminoid Ammonia : (Wanklyn) To the water remaining in the flask after distilling 150 cc, in above experiment, add 50 cc of strongly alkaline solution of pot. permanganate and continue the distillation. Estimate the ammonia of each 50 cc of distillate, until no more distils over.

Oxidisable matter : ("oxygen absorbed") This refers to the amount of oxygen required to oxidise the organic matters in the water. *Significance* : Organic contamination, nitrites, ferrous salts,

H_2S. *Test*: To 250 cc of water, and 3 cc of water, add 3 cc H_2SO_4 and K_2MnO_4 solution (which yields 0·1 mgm of oxygen for each cc) till pink coloration. Heat it all to 140°F, adding more K_2MnO_4 solution, till pink coloration is permanent for 15 minutes. [The oxidisable matter is determined in terms of oxygen required, from the number of cc's of K_2MnO_4 solution used]. But the ease of oxidation is no index of the real amount of pollution.

Metals: [1] *Iron*: (*a*) Water + $(NH_4)_2S$ = dark colouration. (*b*) Dark colouration + HCl = clears up. (*c*) Water + K_2FeCy6 = Prussian Blue. [2] *Lead*: (*a*) Water + $(NH_4)_2S$ = dark colouration. (*b*) Dark colouration + HCl = no change. (*c*) Water + K_2CrO_4 = yellow ppt. [3] *Copper*: (*a*) Water + $(NH_4)_2S$ = dark coloration. (*b*) Dark colouration + HCl = no change. (*c*) Water + K_2FeCy6 = bronze colouration. [4] *Arsenic*: Apply Marsh's test. [5] *Zinc*: To concentrated water add NH_4OH = white ppt.

TABLES.

I. Table of Maximum Permissible Impurities:

Not permissible at all: Lead, Arsenic, Copper, Nitrites, or other animal organic impurities. **Permissible**:—

	in parts per 100,000
Hardness, Total	30° metrical.
Permanent	5° ”
Iron	$\frac{1}{4}$ gr.
Lead	1/20 ”
Copper	1/15 ”
Zinc	1/10 ”
Chlorine	4·
Nitrates	·5 to ·35
Nitrogen as Nitrate	0·35
Total combined	0·4
as Nitric Nitrogen	0·5
Organic	0·02
Ammonia, albuminoid	0·01
free	·005
Carbon, organic	0·2
Phosphates as P_2O_5	0·5
as Mag. phosph	10

Rates of $\frac{\text{organic Carbon}}{\text{organic Nitrogen}}$ should be not less than $\frac{7}{1}$ or $\frac{6}{1}$.

Oxygen absorption in 15 minutes	·1
3 hours	·3

II. Evidence of Source of Impurity—

1. ORGANIC (*a*) Presence of Nitrites and Nitrates in association with excess of chlorine and ammonia = *animal* excreta [Presence of bacilli of intestinal group and of excess of phosphates and sulphates confirms this view]. (*b*) Presence of excessive organic matter without excessive Cl, or nitrites and nitrates and free NH_3 = *vegetable* source. [Albuminoid ammonia does not necessarily imply animal source].

2. METALS like lead, zinc, iron or copper are obtained from *pipes or cisterns*.

III. Evidence of Period of contamination :

(*a*) *Contamination is remote* if there be present : (i) Nitrites, Nitrates. (ii) Bacteria, amœba, infusoria. (iii) Excess of chlorine.

(*b*) *Contamination is fresh* : if there be present : (i) Bacilli of intestinal group specially the colon bacilli. (ii) Ammonia. (iii) Raw sewage. (iv) Hair, epithelia, muscle fibres, cabbage, cauliflower, starch &c.

IV. Evidence of sewage Pollution of water

CHEMICAL : Excess of *chlorides*, presence of *phosphates*, excess of *nitrites* and *nitrates* (over ·35 parts per 100,000), of excess of *salines* and *albuminoid ammonia* (·005 and ·01 parts respectively per 100,000), and of excessive amount of *easily oxidisable organic* matter.

MICROSCOPIC : Presence of fibres of cottonwool, linen, starch cells, macerated papers, human hair, yellow globular masses, striped muscular fibres.

BACTERIOLOGICAL : Presence of—b. coli, streptococci, b. enteritidis sporogenes, b. typhosus, b. comma &c.

CHAPTER IX.

(A).—SOIL.

Source of soil.—This earth was once in a molten state and in the process of cooling down, it formed a *crust* of "igneous" rocks (*i.e.*, rocks produced by the action of heat). By the actions of rain, frost, wind, changes of temperature and roots of plants, the igneous rocks became gradually worn down into fine shreds, which, by conglomeration, have produced the "sedimentary" rock. The surface of the earth, or soil, is the result, therefore, of (1) thousands of years of breaking up of these various rocks (which are often found on digging down and down) and (2) the remains of vegetable and animal matter that it has sustained in times past.

Soil, then, is disintegrated rock (mineral) plus decayed organic (vegetable and animal) matter.

Division :—For our purposes, soil is divided into :—

(*a*) **Humus or Soil**—the upper and more porous layer, which is richer in *organic* than in mineral matter (except in deserts). The organic matter is mostly decayed animal or vegetable matter (forming *mould* or "*humus*") as well as living bacteria (which are more numerous here than at depths below). By various processes of oxidation and reduction, bacteria *nitrify* the soil, *i. e.*, decompose organic matter into nitrites and nitrates, in which form plants can take up their required nitrogen. It also receives much alluvial deposit and is turned up by burrowing worms and animals &c.

(*b*) **Sub-soil**—the lower and denser layer—is richer in inorganic (*mineral*) than in organic matters and it extends for several hundred feet in depth, till it merges with the formation to which it owes its origin.

Features of soil influencing health :—As the sub soil retains moisture, air, heat and a mass of organic matter (living and dead), all which can react on, and be reacted upon by, the atmosphere and influence the health and climate of the place, we have to consider each of these disturbing factors :

I. **General Contour of the Country**.—*Hills*, if of considerable height and length, act as barriers to prevailing winds and influence rainfall and temperature considerably; they give rise to streams and often to dense vegetation; hence, while hill *tops* are healthy, closed *valleys*, *ravines*, *saddle-backs* and *places at their foot* (*e.g.*, the Terai) are unhealthy, owing to water-logging, dampness and malaria.

II. **Vegetation**.—Trees serve 5 useful purposes : (*a*) they keep slopes and river-banks from *erosion* ; (*b*) they increase *rainfall* over the locality ; (*c*) hence, they influence local *temperature* ; (*d*) in case of comparatively dry soils, trees prevent too rapid *evaporation of water* ; and in case of damp soils, they abstract moisture very efficiently, thereby permanently lowering the subsoil water level ; and in water-logged areas (*e*) they use up the *organic* matter of the soil. An *oak* tree evaporates 8½ times and the *eucalyptus globulus*, 11 times the rainfall over the area it covers ; so do the *blue gum tree* and the *sun flower tree*. Dense rank vegetation that obstructs wind and sunshine should be cut down, only to the extent of letting in air and sunshine ; for, reckless DESTRUCTION OF FOREST leads to decreased rainfall, increased organic matter and retention of moisture in subsoil as well as to elevation of local temperature. A dry soil is always cleaner and healthier and trees help much in doing this, if judiciously handled.

III. **Temperature** :—The temperature of the soil is DUE TO : (1) internal heat of the globe, and (2) chemical interchange constantly occurring. ITS BEARING ON SANITATION: By affecting the *activity of the micro-organisms* underground and therefore indirectly, the purity, dryness and warmth of the *atmospheric air*, soil temperature is a great factor in sanitation. IT VARIES WITH (*a*) the moisture present in the soils (∴ on the amount of rainfall, snow-fall, drainage of subsoil water &c.), (*b*) on their geological formation, (*c*) their colour, (*d*) on the kind and thickness of the vegetation growing on the soil. Sandy and dark coloured soils warm quicker, while moist soils and white-coloured soils warm slower. Sands cool slowly, while clayey and vegetable-studded soils cool quicker. THE TEMPERATURE IS TAKEN (*a*) at a depth of 1 to 4 ft. from the surface, or (*b*) by a flat coil thermometer laid on the ground. DAILY & ANNUAL VARIATIONS.—Beyond 3 or 4 feet, the *daily* variations do not go; while *annual* variations do not go beyond 40 ft. below. Ordinarily, for every 60 ft. downwards, the *soil temperature* increases 1° F. RELATION TO (*a*) ATMOSPHERIC TEMPERATURE: As a rule, the "surface" soil temperature is warmer in the *day* and cooler in the *night*; (*b*) TO SUBSOIL TEMPERATURE: the "sub" soil is colder in *summer* and warmer in *winter*,—the heat and cold in the "sub" soil being higher than those of the "atmosphere", owing to slow heat conducting power of soils.

IV. Ground Air.—The soil is composed of grains; these are so arranged as to leave interstices or *pores* between them. These pores are filled with air in the proportion of 1 to 2 or 3 of soil—the *permeability* of the soil being greater, the larger the grains. *Porosity* of the soil refers to the power which soil grains have to allow water to pass 'through' them, apart from its passage through the pores 'between' them. Except in the hardest rocks, air is found in all soils. Its AMOUNT varies with the looseness of the soil: loose sands contain 40 to 50%, soft sandstone, 20 to 40°/₀, loose surface-soil, many times its own volume. ITS COMPOSITION*: (*a*) *Nitrogen*,—constant and equal in amount to that in atmospheric air, (*b*) *Oxygen*,—which decreases with depth, (*c*) *Carbonic acid*,—4 to 8%, the quantity increasing with the amount of moisture, permeability, organic matter, temperature and depth of the soil, (*d*) *Moisture*, (*e*) *Organic matters*,—(present even in virgin soils and diminishing with depth) are chiefly vegetable in nature; but organic matters are mostly of animal origin, if derived from houses, graveyards, made soils &c., (*f*) *Gases of decomposition* (NH_3, CH_4, H_2S). *Ground air is always impure.* The quantity of CO_2 in the ground air is a better indication of the permeability of the soil than of its impurity. ITS MOVEMENT: The ground air is constantly moving: the directions and causes of movement are:—(*a*) *Downwards*—when heavy rain falls on the surface, when ground water falls in level, or when barometric pressure rises; (*b*) *Upwards* (into atmospheric air)—when ground water rises in level, when the surface is heated or barometric pressure falls, when heavy wind blows over the ground or when ground temperature rises. EFFECTS OF MOVEMENT:—Like in lungs, air is continuously passing into soil and out of it to the atmosphere. If a house (*a*) has permeable basement (as is common in huts), (*b*) if it is artificially heated by fire &c., as in the kitchen, (*c*) if paved or cemented streets and foot-paths are about it, and (*d*) if there occur leaky cess-pools, gas pipes or sewer pipes passing underground, (even at 20 ft. depth)—then noxious gases

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*As heat + H_2O + O are favourable to **bacterial** activity, the soil is a laboratory for purification and utilization of effete organic matters; where these are present, bacteria are continuously at work, breaking up organic matter into simpler compounds. These products are partly given up to the vegetables growing on the soil, partly to the underground water and partly to the atmospheric air, which gets contaminated thereby. In the ground air of pure soils, no micro-organisms have been found, as in the Shahara desert.

from these are aspirated into the houses, causing ill health, foul smell and even explosions. Hence, it is a salutary rule—(*a*) never to allow tenants in uncemented cellars, (*b*) never to build houses on made soils and (*c*) never to build houses on any soil without asphalt, or cementing over at least 6 inches concrete or having raised floors on arches with perforated bricks against the floor walls.

ESTIMATION OF PERCENTAGE OF AIR IN SOIL :—This is found by the help of this formula :—

$$\frac{\text{Amount of } H_2O \text{ used}}{\text{Amount of dry soil used}} \times 100.$$

One graduated burette is filled with dry soil in fine powder ; into it is run, by means of a clamped tube, water hitherto kept in another graduated burette, till the water just reaches the soil-surface. Then apply the above formula.

V. **Ground Water.**—DEFINITION : (1) Ground *water*—is a continuous sheet that completely fills the interstices between the solid particles of the soil ; it lies below ground air. (2) Ground *moisture* (dampness)—is water in vapoury form, found mixed with ground air.

GROUND MOISTURE. It is *derived from* (*a*) the ground water, by capillary action and evaporation and its rise and fall and (*b*) from rain. It is *aggravated by* (*a*) irrigation and (*b*) obstructed drainage. It is *being continually lost by* evaporation from surface of soil and through vegetation. It *causes* the soil to be damp and unhealthy, the atmosphere humid and decomposition of effete organic matter to proceed apace : decomposition is best with 4°/₀ moisture, less active with 2°/₀ and retarded when moisture is over 4°/₀. *Capacity* of a soil for moisture increases with the amount of organic substances present. *Permeability* to water depends on (*a*) nature of soil (clay, marl, loam, limestone, chalk &c.) and (*b*) condition of soil as regards saturation with moisture : gravel, chalk, sand, sandstone, and vegetable (peat) soils are very permeable ; trap or metamorphic rocks, unweathered granite, hard lime-stone, and dense clay are more or less impervious. Its *absorbability* or *retentiveness* varies with the fineness of the pores of the soil. Moisture is *estimated* by weighing the soil before and after drying.

GROUND WATER : *Derived from* rain and nearest water-way. *Destination* of ground water : Part of it evaporates by reaching the surface by capillary action ; part reaches a stream or a portion is forced to the surface as spring. *Depth at which found*—varies with (*a*) elevation of of the district and its surroundings ; (*b*) depth of impenetrable stratum from surface ; (*c*) accessibility to sea or surface (as spring), and (*d*) rainfall. The *depth is ascertained by* noting the water-level in several wells of the place. The distance from the surface at which sub-soil water is found may be 1 to 2 feet to hundreds of feet. *For purposes of health*—(*a*) this level should never be nearer the surface than 10 or 15 feet and (*b*) sudden changes of level (due to inundations) are more injurious than a persistently high level of water, as the former discharges into the atmosphere bad gases and into nearest wells, polluted water. (See p. 123) *Movements* of the ground water are of two kinds : (*a*) rise and fall in level within a few inches (though in India even 16 feet have been recorded) and (*b*) forward movement towards a stream or as a spring. This latter is a constant flow at the rate (as calculated at Munich) of 15 ft. daily and it is *impeded by* (*a*) interposition of impermeable layer, (*b*) deficient slope of the soil and (*c*) roots of trees. *Fall in the level* is due to dry season and improved sub-soil drainage. *Rise in level* is the result of (*a*) increased rainfall, (*b*) obstructed out-flow and (*c*) swollen river, as hinted above. *Means of drying the soil* are : (1) planting eucalyptus trees, (2) opening the natural out-flow,

(3) subsoil drainage—by laying porous pipes 6 feet apart and 1 to 3 ft. deep from the surface, and (4) deep drainage.

Dampness of Soil.—Its **Causes** are :—(1) RETENTIVENESS OF SOIL : stiff clays, marls, alluvial soil mixed with clay—are themselves cold, foggy and damp and allow rain to lie long on the surface, forming puddles or swamps, breeding mosquito. (2) EXISTENCE OF IMPERVIOUS LAYER NEAR SURFACE : Thus, gravels, sands and chalk are very healthy soil, if deep ; but, if they are shallow and rest on an impervious stratum, will accumulate a sheet of water and cause dampness. As said above, for the impervious layer to cease to be unhealthy, it must be at least 6 feet away from the surface. (3) OBSTRUCTED WATER-WAYS—from silting up or neglect : these give rise to "beels" and "jollas" (*e.g.*, the old bed of the river Hughly) (4) FAULTY ENGINEERING, *e. g.*, *(a)* introduction of water supply to a place without providing adequate drainage ; *(b) digging pits* to find sufficient earth for raising embankments or huts or making brick ; these pits should be forbidden and the digging of a regular tank for the purpose should be insisted on, or these pits should be properly drained into the nearest water course ; (*c*) raising long *embankments* across a country, —without providing for culverts of sufficient size and number, or without following the watershed of the country ; (*d*) *irrigating* a country—by constructing canals and their branches across the line of watershed, by not limiting the water supply to the actual needs of the country and by not providing for drainage along the natural line of outfall of the district.

Healthy Soil.—Pettenkofer was right when he said that we do not leave home for change of *air*, but for change of *soil* —for, air over any place is in a state of perpetual flux, and the character of the soil permanently influences the climate of the locality. And, a soil is healthy when it possesses—(1) good *drainage*, *i. e.* is dry and high and free from organic emanations, (2) sufficient, pure *water supply* (3) and moderate amount of *vegetation*.

Classification of Soils as to their salubrity (after Newsholme). (1) *Granitic*, *Basaltic* or *Trap Rock*—being greatly sloped, is dry and healthy. (2) *Clay Slate*—is well sloped, dry and healthy, though liable to occasional floods and to deficient water-supply and vegetation. (3) *Hard Oolite and Magnesium Limestone Rocks*—are well drained and sloped—hence healthy. Marsh gas formation should, however, be looked for. (4) *Chalk Soil*—is well sloped and healthy when permeable and unmixed with or underlaid by clay (which latter renders the soil damp); goitre is likely to be endemic. (5) *Sandstone* (*hard millstone grit*)—is dry and healthy, if unmixed with clay or if clay bed is not lying very near to surface. (6) *Gravels*—if deep and if not water-logged owing to lying below the surrounding surface, are healthy. (7) *Sands*—are healthy if of considerable depth, if unmixed with organic matter and if not shallow and lying on a clay base or near water. (8) *Clay*, *Dense Marls*, *Alluvial soils generally*—are always damp; they are healthy if properly drained. (9) *Cultivated Soils*—are not healthy for building sites as they offer good breeding grounds for mosquitos. Soils where rice or jute is cultivated are necessarily unhealthy and damp. (10) **Made Soils**—are unhealthy for building sites, on account of the use of street refuse in filling them up. The organic matter is rendered into harmless inorganic bodies by the action of bacteria—hence foul gases emanate continuously to facilitate the bacterial activity; it is necessary to protect such soils from periodical floodings by rain; and to abate nuisance, it is necessary to expedite the work or to take it up in compartments and finish it quickly, covering each day's deposit with half to one foot of good dry earth. Such soil can be used for gardening or cultivation in 3 years' time and no house should be built on it, unless it is provided with air-proof basement of concrete (6 inches thick) or raised on well-ventilated arches or cellars. **The best** soils are *gravel* and *sand*—when of considerable depth and well drained ; **the worst** are : shallow beds of *gravel* or *sand* lying on clay, so-called *alluvial* lands, *reclaimed* lands near mouth of rivers and *made soils*.

Soil in relation to Diseases.—The soil in its upper layers is rich in micro-organisms, the more so in the garden soil and agricultural humus. The micro-organisms found there are saprophytic or pathogenic. The **saprophytic** ones are concerned in breaking up organic matters into simpler bodies (ammonia, nitrites, nitrates etc.) and in purifying sewage when soil is treated to it. The **pathogenic** organisms are *derived from* human or other animal excrementa and find a suitable nidus in the moist, organically rich, warm soil ; the soil *transfers them to man* and animals. Some of these germs possess tenacious vitality.

Various diseases have been associated with the varying level of **ground water ;** but the truth is that ground water *indirectly* acts on human constitution, by lowering its resistive power ; and, causing general depression, it gives rise to *phthisis*, *neuralgia*, *catarrh*, and *rheumatism*. The ground water acts as a *direct* distributor of germs thus : (i) when ground water *rises* in level, it forces germ-laden ground air into the atmosphere ; these germs settle on food and drink, or are carried about by wind ; hence we find an all-round wide distribution of germs due to changing ground water-level. (ii) when the ground water *sinks*, it discharges the germ-laden water into the nearest source of water supply or to vegetables growing on the soil and by supplying warmed ground moisture helps to resusciate or keep alive the germs already existing in the soil. Hence, *permanent* lowering of ground water level by efficient drainage, rids a country of several diseases. The diseases associated with soil are :—

1. *Enteric fever*, *Cholera*, *Diarrhoea* (*epidemic or summer*), *Dysentery*.—Most of these are water-borne ; their germs pass from human body (‘carrier’) to the soil and thence into drinking water ; or dust containing these germs get into food and drink. The advent of summer helps to resusciate the germs or to spread them afar and afresh—hence their seasonal prevalence.

2. *Malaria*, *Yellow fever*.—These are transmitted by mosquitos ; and a damp soil riddled with pits is the most favourable opportunity for breeding mosquito. In Bengal, in consequence, malaria rages towards the end of rainy season.

3. *Anthrax* (wool sorter’s disease), *Tetanus*, *Malignant oedema*, *Plague*, *Diphtheria*, *Phthisis*.—The germs of all these find in the damp soil a suitable nidus, and are transferred to man and animal when their system is depressed by damp, ill-ventilation or bad or insufficient food.

4. *Calculus*, *Goitre*, *Dyspepsia*, *Hill diarrhoea*.—These may be due to minerals existing in the soil being yielded up to the source of water supply.

5. *Worm* (*ankylostoma duodenale*).—These inhabit the soil and may thence be transferred to man.

(B) CONSTRUCTION OF DWELLINGS.

The Principles involved in constructing dwellings are :—(1) Selection of a Site *i. e.* the nature of soil, its aspects, its surrounding. (2) Details of construction. (3) Water-supply. (4) Disposal of Refuse.

Dampness of a house is due to—five classes of causes.

(*a*) *Damp soil*.—This can be guarded against by having

(i) as the foundation of the house, dry concrete 18″ thick and 4 times broader than the walls of foundations ; (ii) damp proof course in the wall ; (iii) air spaces between foundation walls ; (iv) building the house on arches, the foundations at the surface having air bricks ; (v) well concreted or asphalted basement.

(*b*) *Bad Street-making*—streets being full of slush and mud. They should have a firm, dry foundation, with a hard, tough, compact and moderately convex surface.

(*c*) *Defective position of house*—such as, wedged in between other houses, or in narrow lanes lined by tall houses. Opening up roads is the only remedy.

(*d*) *Peculiar Indian customs and habits*, chief among which are : (i) houses being built on courtyard principle, the taller the building, the smaller is the well-like courtyard left for ventilation and sunlight ; (ii) houses being recklessly partitioned, without reference to provision for light and air ; (iii) washing of practically the whole house twice a day ; (iv) having dark, ill-ventilated ground-floor, with its whole host of—kitchen, scullery, baths, wash, urinals, latrines, godowns, etc. ; (v) hanging heavy curtains to ensure privacy ; (vi) planting trees too near the house ; (vii) free use of water, several times a day, for bathing, washing cooking pots etc., on the small, ill-ventilated, courtyard, riddled with cracks and holes.

(*e*) *Faulty construction*, *e.g.*, leaky roof ; insufficient or misplaced windows ; leaky taps ; defective roof gutters, window sills not projecting beyond walls ; cornices not having slopes and being built of soft bricks ; parapet walls, gables etc. not being properly covered with coping ; basement not well cemented etc.

I. Nature of Soil and its Surroundings.—IT SHOULD BE elevated, dry, porous, well-drained or capable of drainage, with a fairly constant level of subsoil water at 12 to 15 feet below surface. IT SHOULD NOT BE—on marshy or "made soil," on alluvial soil, on the slope or side of or close to a hill, on banks of rivers, on shallow beds of gravel or sand overlying clay, near cesspits, marshes, irrigation works, paddy fields, cowsheds, stables, graveyards, bustees or bazars or places of dangerous or offensive trade; it should not be liable to sudden fluctuations of its ground water level or to contamination of it nor should the ground water be less than 10 ft. from surface. THE BEST SITE is a gentle slope on a gravel soil. Clay fosters dampness and gives rise to rheumatism, phthisis, dysentery and malaria. Sandy soil, if turfed over, can be used.

II. **The Aspects** (*i.e.*, exposure to light, air and wind). (*a*) It is desirable *to have free circulation of* **Air**, but it is undesirable to have constant draughts, specially cold draughts in winter. For this purpose, it is necessary—(1) to build on streets as wide as the height of houses, avoiding narrow courts, alleys and back-to-back house-building; and (2) to have in front and behind a house an open area at least equal in length to the height of the building.

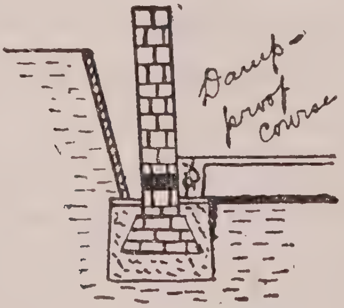
(*b*) *To prevent* **draughts,** (1) have a belt of trees or some rising ground on those aspects that are exposed to prevailing cold winds (the north and the east); [trees also keep the house cool in summer; but if they are planted too close, they render the house damp, by keeping out light and air] and (2) have porch or other protections over entrance-doors.

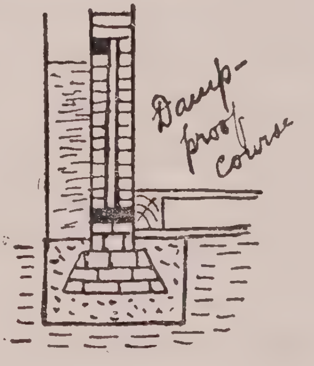
(*c*) **Light**: The following arrangement seems best for the positions alloted to the various components of a building:—*Facing South and west*—have living rooms. *Facing North*—have working room, dining room, staircase, larder, pantry, dairy. *Facing North East*—have bed-rooms. *Facing South East*—have bed rooms, sick rooms. *Facing East*—have breakfast room, morning room, library.

III. Building Materials :—In constructing buildings, adequate provision must be made for—(*a*) durability and safety ; (*b*) freedom from damp and for rendering the building proof against weather ; (*c*) keeping air inside, pure and wholesome ; and for (*d*) cleanliness—*i.e.*, disposal of refuse.

MATERIALS USED IN HOUSE CONSTRUCTION are :—(1) *Mortar*=Slaked lime 1 part + clean sand 3 parts + water (fresh). Sea sand and sea water are undesirable. (2) *Bricks* —are either burnt, sunbaked or "hard stock". Sunbaked or crude bricks are no good. Compared with stone walls, brick walls are more economical of heat, which they conduct and resist well. The desiderata of a good brick are : shape—regular ; colour—uniform ; weight—7lbs ; size—$8\frac{3}{4}'' \times 4\frac{1}{4} \times 2\frac{3}{4} = 102$ cub. inches ; must be well-burnt, give a clear metallic note when struck, be porous (absorbing $\frac{1}{7}$ to $\frac{1}{5}$th their bulk of water—each brick absorbing nearly a pint. (3) *Stones*—are usually of two varieties—Sandstone, which can be had of various colours ; and Lime-stone. Stones are, like bricks, porous and absorbent of water, though to a less degree. If good stone is not available, it is better avoided altogether in building walls : the best stone is one that is least porous, densest and resists crushing. For ornamental purposes, granite and marble (and even enamelled slate) are used. Stones do not resist fire so well as do bricks, nor do they keep out wet so well : hence, stone houses have to be built thick and they keep cooler in summer and warmer in winter. Artificial stones are costly and of doubtful value. (4) *Concrete*—a composition of gravel and cement or lime. It keeps out weather excellently but is, at the same time, porous and fire-proof. (5) *Slate*—is altered clay ; being laminated, it splinters off. (6) *Flint work*—used in small buildings. (7) *Terra cotta*—well burnt clay, which lends itself to various kinds of ornamentation. (8) *Wood*—It should be well seasoned, close and straight-grained, free from cracks and dead knots. It makes the walls picturesque but exposes building to risk of fire. (9) *Lead*, *zinc*, *corrugated* or *galvanized iron.* (10) *Thatch*—protects room from extremes of temperature but is liable to rot, to catch fire and to harbour insects and to be injured by birds and animals. (11) *Plasters*—are coatings, of which cement or lime forms the basis, ox-hair, sand, gypsum being mixed with them. They make the walls smooth ; but if they are porous, they hold dust and organic emanations from dwellers and get fouled soon. (12) "*Light construction materials*" (for temporary buildings) =hollow stone ware slabs supported by steel piers and framing. (13) "*Reinforced concrete*"=concrete strengthened by steel rods and ties introduced in its substance.

IV. **Foundations.**—(*a*) **Protect them from subsidence**—(i) Situate them on rock foundation or on a uniform bed of earth (*i.e.*, not partly gravel and partly on clay) and avoid clay slopes and untested chalky beds. (ii) Have the lowest "footings" at least twice the width of the wall and the cement-concrete below footings at least twice their width and 18″ thick.





(*b*) **Protect them from damp**—by one of these three means : (i) If the soil is damp—drain it by unglazed agricultural pipes laid in trenches and filled in above with pebbly gravel [Such subsoil drain is to discharge into a ditch or stream ; or, be connected with house-drain or sewer, after proper disconnection has been practised]. (ii) Provide open area, in the shape of an excavation all round the four walls, extending upwards from the footings. [This is not feasable in India not at least in flat and rainy Bengal.] (iii) Have dry areas or vertical hollows in the walls, extending from a point below the floor level and upto a point above ground level—a damp-proof course being laid at the top and bottom of the hollow.

V. **Basement.**—The points about it to be secured are: freedom from (*a*) damp and (*b*) entrance of ground air into the house. These are secured—(i) By having a continuous bed of 6″ concrete in cement (or asphalt) all over the area occupied by the house, or (ii) By building the house on well ventilated arches. In such cases, the ground surface must be kept dry and free from decomposing refuse matter or odds and ends. or, (iii) By cementing the ground for at least two feet well around the four walls, so as to prevent rain water soaking into ground or (iv) By putting in damp-proof course where the footing ends and the wall begins. (v) By building the house on airy cellars. [A cellar to be habitable, must be at least 7 ft. high (3 ft. being above the level of the street); it must have an open area of at least 2½ ft. wide in everv part and 6 in. below floor-level, extending along the whole frontage; have a drain at least 1 ft. below floor; and, an window at least 9 sq. in. in area]. Or, (vi) Where the basement is below the street-level, it should be well concreted in cement, asphalted, tiled or paved with solid wood blocks.

VI. **Walls**—are MADE UP of (*a*) bricks or (*b*) stone or (*c*) of both or (*d*) of bricks and wood or (*e*) concrete in cement. The OBJECTS of walls are (*a*) to afford support and binding to the building, (*b*) to keep out damp and wind; (*c*) safety. Of these three, we are concerned with the second *viz.*, prevention of damp and draught. The HEIGHT of every room must be at least 9 ft. and the THICKNESS of its walls is determined by the size and height of the building.

To prevent damp,—have recourse to one or more of these—

(*i*) Build walls of at least $1\frac{1}{2}$ bricks (=15″ thick) because, each brick is porous and it is the mortar between them that to some extent prevents dampness. [Moreover, a thin-walled house is hot in summer and cold in winter.] (*ii*) Protect OUTER WALL by re-pointing or covering over with slate slabs, glazed tiles, painted planks, painting with silicate, plastering, cementing or mortar sprinkled with small stones. (*iii*) Build DOUBLE WALLS with a vertical air-space between (the air space being filled with asphalt to prevent in-roads of rats.) (*iv*) Insert a horizontal DAMP-PROOF course of—slab of slate laid in cement or perforated glazed stone-ware or sheet-lead or iron or tarred bricks or a mixture of fresh slaked lime and vegetable oil, or 1″ to 2″ asphalt. [The course is to be laid (*a*) 6″ above the ground-level, (β) at top of exposed walls beneath the roof timbers (*e.g.*, parapets) and (γ) at junction of chimney with roof. In existing buildings, damp proof course may be inserted by removing piecemeal a course of bricks and inserting air-bricks in section.] (*v*) Avoid *defective* roof-gutters, broken or leaky rain-water pipes, over-flowing cisterns, cracked floors, choked drains and pipes. Window sills and cornices should be sloped and well projected; parapet walls, gables &c. should be properly covered with coping. *Chimney* flues should be built straight, separate from each other, higher than surrounding buildings, should be lined with pipes, be devoid of timber-work and a damp proof course should be inserted at the junction of chimney with roof. (*vi*) Have INNER WALLS covered with—cement or glazed bricks or tiles, painting (in oil), distempering (=plaster or chalk + yolk or size), white washing (=whiting or chalk + water with or without alum, gum &c.) or lime washing (=quick lime and water), sand-plastering, covering with polished wood or papers. [The above while keeping out damp, also keep out ventilation. *White-*

washing keeps wall rough (therefore dusty) and absorbs organic matter; hence, it is undesirable and must be frequently renewed. *Wood* rots and is liable to catch fire. *Papers* unless varnished and if fluffy, lodge dirt and rot. They are less expensive and suitable for walls with rough surface and they are absorbent as well as retentive of moisture. They should be scraped before new ones are put on. Putrid size and paste should never be used in hanging papers. Basement rooms are not to be papered. To *lime-wash*, the old coat has to be scraped off first. *White lead paint* gets spoiled by H_2S from sewer, decomposition &c. and gives rise to colic; while, if painted on iron, it sets up injurious galvanic action. "Carlton white" (oxy sulphide of zinc), or Wilkins' white paint (=kaolin and zinc white) are safe. *Green paints* are often rich in arsenic and most *brilliant* colours contain lead, arsenic, copper or antimony. Brunswick green, mineral green and chrome green are non-poisonous. Water-closets, bath-rooms and sculleries should have glazed-tiles or painted or cemented walls—so as to be capable of frequent washing; bedrooms may be distempered instead of papered; while, the sitting room may be papered.]

VII. **Roof.**—As defective roofs render houses damp and too hot or cold, it is necessary to consider them under these heads:—MATERIALS USED (must be impervious):—*Slate*—is brittle and may scale off; *Zinc*—is suited for hills or temporary buildings; *Corrugated iron*—is for temporary use and is also very hot in summer and cold in winter, and noisy during rains; it should be lined with felt underneath or have earth ceiling put under the roof; *Copper or Lead*—costly; *Tile*—if well burnt and in double layer, is very cooling; but if in one layer, is very heating; *Wood* (covered with tarred felt or canvas)—is suitable for temporary buildings, but is liable to rot, crack and burn; *Thatch*—is warm and dry in winter and cool and dry in summer, liable to rot, burn and harbour insects and animals ; *Masonry concrete*—laid on tiles and smoothed over. FRAME WORK for suspension—may be bamboo, wood or iron, (the former two of which are liable to harbour insects) or the roof may rest on arches. SLOPE : Roofs may be (*a*) *Flat* or *terraced* with just slight slope to the gutter or (*b*) *sloping* or *pent.* The former affords a promenade and sleeping place in summer but renders the room warmer and less ventilated than the latter, because, heat is radiated from roof in inverse ratio to the square of its distance [The EAVES should always project some distance beyond the walls]. CEILING—serves three *objects :* (*a*) it deadens sounds produced upstairs ; (*b*) prevents penetration of heat ; and (*c*) keeps room clean. It is *made of*—close boards covered with silicated cotton or felt, lath and plaster (painted or distempered). GUTTERS and DOWN SPOUTS should be *made of* lead or iron, should be fixed 2′ to 3″ from the walls all round the lower edge of roof (cement being not used at all) ; they should *discharge* into iron RAIN PIPES, *placed* well outside and away from house walls : tin and porous earthen pipes are also used but are undesirable. Rain pipes should *discharge* into rain-water tanks or over a drain covered by grating—never be directly connected with drain nor have their heads just below bed room windows.

VIII. **Floors.**—They should be—(*a*) dust and damp proof, and (*c*) warm in winter. (*See* Ground-floor under "Basement"). MATERIALS for making floor : (1) *Concrete* in cement and terraced : This is porous, resistant to aqueous saturation and does not catch fire easily. (2) *Wood* (pine, fir, cedar, larch, oak, ash, beech, mahogany, walnut, elm &c.).—They are liable to rot, decay, ignition by fire and to harbour dust between joints. They lend themselves to polishing, varnishing, bees-waxing and unless dry cleaned, they absorb moisture and diffuse damp. [To prevent rotting, ends of woods must be steeped in tar or zinc chloride or charred and kept well aerated by air-spaces around them]. (3) *Stone*, *Slate Slabs*, *Marble*, or *Tile* (glazed).—They are well adapted for sculleries, passages, larders, water closets, bath rooms &c., but being cold are not suited to sleeping rooms or kitchens, unless carpeted. (4) *Rammed earth with kutcha brick floor.*—This is insanitary, just as cowdung lipping of floor is. (5) *Carpet* or *Drugget*—does not make floors but simply covers them. As it collects dust, it is best avoided ; but where used, it should never completely cover the floor and it should be frequently beaten. Exactly similarly may be used—*linoleum*, *oiled cloth* and Chinese or Indian *matting*.

Design and Arrangement : AVOID—(*a*) privies, middens, pigstyes, stables—in or abutting upon the house ; (*b*) back to back building ; (*c*) cramped halls and staircases ; (*d*) using pantry and kitchen as sleeping room or locating the same on the warm side or side where water-closets, diary, stable &c. are situated ; (*e*) narrow alleys and (*f*) fluffy and heavy furniture. ADOPT—(*a*) building houses in rows running north and south ; (*b*) light and air for every bed room. TO ENSURE COOLNESS of rooms in summer : Room should be high, should have double roofs of non-conducting material, should have a proper ceiling, the space between roof and ceiling being well ventilated. There should be deep verandah all round and the wall facing the sun should be thin.

Insanitary rooms are those sleeping places (*a*) whose floor-surface is more than 3 ft. below the road surface level ; (*b*) whose height from floor to ceiling is less than 7 ft. (*c*) whose lighting and ventilation are inadequate and (*d*) which are not protected against damp, effluvia or exhalations.

SPECIAL DWELLINGS.

I. **Residential Quarters** : These are best built in complete BLOCKS,—each one independent of the other as regards drinking water supply, lighting, drainage, bath and kitchen-arrangements, and built on a plinth of 2 or 3 feet, containing 20 rooms and each block situated 20 ft. apart. SANITARY arrangements should be complete in every detail as regards—water-supply, drainage, open-area (light and air), childrens' play ground. Each block should be at least two storied, the lower storey being 9 ft. and the upper 8 ft. high and COMPRISE at least—(*a*) one *living room* 150 sq. ft. in area, fitted with a cupboard and well lighted and ventilated by a separate window ; (*b*) one *parents' bed room* (at least 80 ft. in area) and (*c*) one or two *childrens' bed room* (each at least 50 sq. ft. in area ; (*d*) a *scullery* (at least 10 ft. × 7½ ft.)—adjoining the living room and leading into (*e*) a *pantry*, which must be dry, cool and lighted ; (*f*) *kitchen* should be on top floor and *privy* and refuse platforms should be in a shed out of doors, but close by and reached by covered passages. But in no case should groups of closets, common to two or more houses, be placed in the childrens' play-yard. For every six persons, there should be one closet ; (*g*) *servants' quarters* should also be under separate shed. (In no case must the water-closet be near bed-room or kitchen or ventilate into a hall or passage ; and if more than one closet is necessary, it is better to build them one upon another).

II. **Artisans' Quarters**—These must be built on sectarian principle with proper regard for zenana and as near the work place as possible. (*a*) They should be built on the above model, if they are storied buildings, built in rows. In no case should they abut on a narrow corridor of 8 to 10 ft. If however, it is intended to economise ground space, two or three storied buildings may be built on each side of a staircase—each building being detached from the other and having no stagnant corners. *Sleeping Room :* Area 10′ × 10′ × 10′ for a family of man, wife and 2 children. It must be well lighted and ventilated and on one side at least abut on an open space of 20 ft. or more : or if the rooms are in two rows, open into a passage 20 ft. wide. (*b*) Where huts are the tenements allowed, the rules relating to bustee should be applied.

III. **Bustee.**—*This is* an area of land studded with huts which are meant chiefly to be let out on rent. To keep such an area sanitary, it is necessary to conform to these regulations :—

LAYING OUT :—(*a*) Individual huts are to stand in *regular lines*, with a *space* of 6 to 10 ft. between each. (*b*) *Streets* in bustees shall be at least 20 ft. wide and laid every 200 ft. apart. (*c*) In front of and behind every hut, a *passage* at least 15 ft. wide must be provided for. (*d*) Every *tank* must be filled up, if there is good water-supply otherwise available ; if not, one tank must be reserved exclusively for drinking purposes and another used for washing &c. (*e*) Where water-supply is by means of taps, regular *bathing* platforms (for males and females separately) should be provided, well supplied with unfiltered water. (*f*) Taps of *filtered water* must be also provided. (*g*) The whole area must be well *drained* and sewered and properly scavenged. No cesspits are to be permitted ; covered dustbins on cemented platforms should be provided at regular distances.

HUTS : *Height*—not more than 16 ft. *Plinth*—should be of masonry work and at least 2 to 3 ft. high. *Floor*—should, if possible have a damp-proof course, be of concrete in cement. If it is not possible to do so, cowdung lipping should be discouraged and the floor dug up every few months and filled with fresh earth. *Walls*—are made of bamboo-matting with or without mud lipping, or of tin or corrugated iron or of wood. When mud lipped, they should be periodically white-washed. *Roof*—made of thatch or country tiles ; it should slant on all sides and provide for ridge ventilation. *Courtyard*—should open to the sky and all rooms should open into it. *Windows*—2 ft. square and at least two in number should be situated opposite to each other. *Latrine*—should be built, outside premises, of bricks and on concrete cemented floor.

IV. **Pilgrims' Lodging Houses.**—As outbreak of cholera and infectious diseases from overcrowding and dirt are to be feared in these places, the houses should be well *ventilated* and aired and the *water supply* should be abundant. Rigid care should be taken to guard by policemen the wells or tanks reserved for drinking water and an *isolation ward* should be attached to these buildings. These buildings may be built on the principles of bustees or if they are masonry buildings, the artisans' quarters may be adopted as model.

V. **Abattoirs and Market Places.**—*See* pp. 58, 61.

VI. **Hospitals.**—SITE: An *elevated* ground with excellent *drainage* slope, free *air* circulation, abundance of *light*, easily *accessible* but as remote as possible from *noise* and *traffic* and capable of future *extension.* The AREA REQUIRED is roughly 120 sq. yd. for every bed. WHAT A HOSPITAL SHOULD COMPRISE:—(1) Wards. (2) Administrative block. (3) Nurses' and Resident medical officers' quarters. (4) Anæsthetic room. (5) Operation room. (6) Observation ward. (7) Mortuary. (8) Postmortem room. (9) Laundry (10) Kitchen. (11) Rooms for ventilating, heating and lighting plants. (12) Outpatients' room. (13) Dispensary. (14) Emergency room. (15) Sanitary conveniences (bath room, lavatory, slop sink, water closet &c.). (16) Convalescent wards. (17) Fresh air balconies. (18) Ambulance Room. [(19) Disinfecting room & (20) Incinerator—in cases of Isolation hospitals]. DETAILS OF WARD CONSTRUCTION—*Situation*: (*a*) One-storied wards are better ventilated than two or three storied ones are. (*b*) They should be so situated as not to ventilate into one another. [In the case of Isolation hospitals, what is known as the pavilion system of arrangement of wards or blocks is recommended, each disease being assigned a block, absolutely disconnected and at least 40 ft. apart.] Wards should under no circumstances be situated in the same blocks with—sanitary conveniences, administrative blocks, outpatients' department, laundry, mortuary, p. m. rooms. [Isolation hospital should have a wall at least 6 ft. 6 in. high all round it, about 40 feet away.] *Cubic Area.*—A big ward may contain 24 to 32 beds. Each patient should have as (*a*) floor space—120 sq. ft., (*b*) air space—1500 c. ft., (*c*) wall-space—8 ft. for each bed. Height should be 12 to 15 ft. [In Isolation hospitals, these figures should be: Floor area—140 to 200 sq. ft.; cub. space—2500 to 3000; wall space—12 ft.] [Cubic space and air space will have to be proportionately increased according to the number of nurses and servants and clinical students ordinarily present.] *Shape*—rectangular is the best. But all corners must be rounded off. *Situation of Beds.*—They should be placed against the wall such that there will be a window between two beds. The wall space between the windows should be 1 to 2 feet wider than the bed. *Ventilation arrangement*: Three to 4,000 cub. ft. of air per hour per head must be provided. The window area should be 1 sq. ft. for every 70 or 80 cub. ft. of ward space. Each window must reach to within 1 ft. of the ceiling and near the head of each bed, about 1 ft. from the floor, air inlet should be provided to ventilate the space under each bed. *Walls*—should be made smooth and impermeable—by plaster, glazed bricks, tiles &c. *Ceiling*—should be cemented or lime washed. *Floor*—should be fire proof, free from crevices and treated so as not to require washing. Marble or cement or wood paving with paraffin ironed into it serve our purpose.

VII. **Sanatoria.**—*See* under Tuberculosis.

To inspect a Building, note ; (1) Name, address, date. (2) The *number of inhabitants* in it, room by room, with their ages, sexes and occupations. (3) The number and nature of *animals* kept in and about the house. The place where and the manner in which they are kept, and the source of water supply for watering them. Are any *grains* &c. stored on the premises ? What about rats and vermins ? (4) *Natural characteristics of the site*—sandy, clayey dry or damp, whether situated at the foot of a hill or near marsh or trenching ground, situation also with regard to prevailing wind, solar aspects &c. (5) *Artificial characteristics of the soil*—whether under drained or elevated or made soil ; the arrangements for drainage. (6) *Its construction :* Materials used, is it hygienic, found in what state of repair (particularly the basement), its power of resisting fire. Is it likely to tumble down easily ? (7) *Internal arrangements* as to disposal of sleeping rooms, stair case, kitchen, scullery and bath rooms (8) *Ventilation and heating :* Amount of open space available. Is it situated back to back ? Amount of cubic space per head allowed. (9) *Water supply*—source, quality, quantity means of storage and distribution, relation to drainage and gas fittings. (12) *Sewage & Refuse disposal*—method and application of method. (13) *Waste water*—method of disposal. (14) *General cleanliness.*

CHAPTER X.

FOOD.

GENERAL INTRODUCTION.

Definition.—"Food is such an edible or potable substance, capable of absorption by the alimentary canal, as is destined to further—(*a*) growth or nutrition (repair of tissues), (*b*) production of energy and heat." Speaking theoretically, air is also a food; and practically, the condiments, the beverages and the accessories of food are parts of food.

Food is adapted to climate: Man's dentition, his small stomach and long intestines destined him to be omnivorous. But as a rule, man feeds himself more or less in accordance with the climatic needs of his abode. The inhabitant of *frigid* zones eats chiefly fats; that of the *torrid* zone, carbohydrates; while that of *temperate* zone is a mixed feeder.

Necessity for food: If the food of a growing child is stinted in quality or quantity, growth is arrested. If a man is worked hard and fed insufficiently, his nutrition suffers. Those who are underfed are devoid of energy and feel the keenness of chill in cold weather much more than those in health.

Proximate Principles :—

[All living organisms are derived from previous living organisms; even the lowest forms of life absorb N, C, H and O; the plants do so from the air. Lower animals (sheep, goats, cows &c.) absorb from the most coarse vegetables the necessary N, C, H and O; and human beings derive their quota of N, C, H and O from animals and plants. Proximate Principles are the various substances which constitute food, consisting of N, C, H and O, combined into complex bodies. The proximate principles are :—

A. **Organic :**

I. NITROGENOUS OR PROTEID : Divided into

(1) *Albumins*, in which the proportion between nitrogen and carbon is as 2 : 7. examples : Albumin (egg), casein (milk), fibrin (blood), glutin (wheat), globulin (blood), legumin (dal, peas), myosin (muscles), syntonin (muscle)

(2) *Albuminoids*, in which the proportion between nitrogen and carbon is 2 : 5.5. Examples : chondrin, elastin, gelatin, keratin, mucin, nuclein &c.

(3) *Extractives* of uncertain composition *e.g.*, kreatin, kreatinin, asparagin &c.

II. NON-NITROGENOUS, which are :—

(1) *Carbohydrates*—which are divisible into (*a*) Starch, (*b*) Cellulose and (*c*) Sugars—dextrin, glucose, maltose, galactose, pectose, lactose, glycogen &c.

(2) *Hydrocarbons* (fats)—fat, butter, ghee, oils.

(3) *Vegetable Acids*—acetic, citric, lactic, malic, oxalic, tartaric &c.

III. VITAMINES—or crystalline bodies of the pyrimidine group, the presence of which in food keeps up the nutrition of the nervous system of the animal and its body weight and the absence of which from food forces the animal to get them from his own tissues. There is a beri-beri vitamine, a scurvy vitamine, a pellagra vitamine and so on. Milk, ox-brain, yeast, rice husk, moong dal contain vitamine.

B. **In-Organic** : These include—

I. WATER.

II. SALTS : Chlorides, phosphates, lactates &c. chiefly of sodium, potassium, magnesium, calcium and iron.

Uses of the several proximate principles :—

1. Albumins are the indispensable elements of a diet. THEIR FUNCTIONS :—(*a*) They provide the material for growth of new and repair of old tissues, (*b*) secrete digestive and other fluids of the body, (*c*) regulate absorption and utilization of oxygen and thereby (*d*) produce heat and energy, (*e*) they form fat for body. Albumin group is the most easily digestible group. Proper supply of the albuminous foodstuffs is of the first importance, because the nutrition of the nitrogen-containing tissues is to all intents and purposes equivalent to the nutrition of the body. To preserve health, the nitrogen taken should be equal to that destroyed. [Withdrawal of proteids leads to gradual wasting and death. Animal proteids are more easily digested than vegetable ones and replace waste quicker. Regarded from nutritive stand-point, animal proteid tissues of whatever nature are mutually replaceable, as are vegetable proteids by vegetable ones.* Proteids are convertible into fats and carbohydrates but not vice versa.

2. **Albuminoids**—Effectually spare albuminates, than which they are less nutritious. Albuminoids save proteids like fats—hence fats and albuminoids are albumen-sparing food; that is to say, to maintain equilibrium between nutrition and waste, if one eats only albumins, one must eat enormous (∴ injurious) quantities of meat; but if with meat, fat or albuminoids are taken, a much smaller amount of meat suffices.

3. **Extractives**: (*a*) *Animal* ones—stimulate flow of gastric juice. (*b*) *Vegetable* ones (asparagin) prevent intestinal decomposition and consequent loss of proteid.

4. **Carbohydrates** are (*a*) in part stored up in liver as glycogen, (*b*) in part supply heat and muscular energy, (*c*) save the waste of proteids and fats, (*d*) supply fat to the body, (*e*) aid to preserve the alkalinity of blood. Carbohydrates fatten a man much quicker than fats themselves. Starch deprivation can

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* The *Tissue formers*, therefore, are: Proteids, mineral substances, water. *Work and heat producers* are: Proteids, Carbohydrates, Fats.

be borne, if fat is given instead. Starch and sugars have the same food value.

5. **Fats**—(*a*) Stimulate pancreatic juice and bile and ∴ help digestion of other food stuffs, (*b*) store, repair and renew fats, (*c*) supply energy and heat and are ∴ important in relation to work and temperature and thereby (*e*) spare proteid metabolism. Though both proteids and carbohydrates can form fat, the whole quantity of fat necessary for the body cannot be supplied by either. Hence the necessity for taking fat. Moreover, a given weight of fat produces more heat and energy than a similar amount of carbohydrate.

Metabolism of fats is dependent on the amount of exercise taken and coolness of weather and is independent of the amount of food taken ; hence, after hard work, specially in cold climate, excess of fat is eaten. *Adiposity* is dependant on (*a*) eating fats to excess by sedentary persons, (*b*) predisposition to form fat cells—a sort of habit of the body. *An obese person* stands heat and privations better than a lean one, inasmuch as during fasting, he converts his own fat into heat and energy and it is only when his store of fat is consumed that he draws upon the proteids of tissues, to keep his temperature and energy. Animal fats are more easily digested than vegetable fats [Fat deprivation leads to rapid loss of health and vigour, and predisposes to tuberculosis, specially in children and youngmen.]

6. **Organic Acids**—Keep up the alkalinity of blood (and thus prevent scurvy) and diminish the acidity of the urine. These are derived from fruits and vegetables, which have otherwise little nutritive value.

7. **Mineral Salts** : (*a*) *Chlorides* form HCl of gastric juice (and thereby help digestion) and stimulate appetite and alimentary secretions. Salt is harmful in dropsy and if taken in

excess, injures the gouty. (*b*) *Potash* salts nourish cells generally. (*c*) *Soda* salts are wanted by the intercellular fluids, and by saliva. (*d*) *Iron* is required for the red blood corpurcles. (*e*) *Phosphates* probably help growth of bones. [Seven pounds of human body is mineral—of which $\frac{5}{6}$th is found in bones alone].

8. **Vitamines :** (*a*) Preserve nutrition of nervous tissues and (*b*) keep up body weight.

9. **Water** : (*a*) Helps digestion by dissolving food, helps the excretion of substances of albuminous metabolism and preserves fluidity of blood. (*b*) *When hot*—stimulates peristalsis and excites gastric secretion. (*c*) *Aerated* waters soothe the mucous membrane and expel flatus. (*d*) *Mineral* waters flush the alimentary and urinary tracts. [Sixty four per cent. of our body is made of water and we daily excrete 100 ounces of water. The amount of water needed is directly proportional to (*a*) the amount of physical exertion made, (*b*) the heat of the body, (*c*) temperature and humidity of the atmosphere, (*d*) amount of solid food taken and (*e*) amount of fluid lost from the body. Insufficient amount of water leads to constipation and to disturbances of circulatory, heat regulating and excretory mechanisms].

The three principal Alimentary or Proximate Principles (proteids, fats or hydrocarbons and carbohydrates or starches) are mutually convertible into each other by metabolic activity inside the body ; thus—out of a *proteid* diet, fat is formed and deposited in those who gormandise in idleness ; with increase of proteids in diet, there is increase of fat in the bitch's milk. A diabetic fed on proteids only goes on manufacturing glycogen. Increase of *fatty* food leads to diminution of fat in human milk ; out of fat-poor diet the cow can give milk rich in fat. In warm climates, ingestion of *carbohydrates* leads to fat deposit. But though the proximate principles are mutually convertible into one another,—proteid itself being convertible into carbohydrates and fats but not vice versa—a purely proteid diet leads to combustion of fat of the body ; on this principle is based the Banting system of obesity cure. A purely fat or carbohydrate diet does not conduce to health.

CHAPTER XI.

SOURCES AND VARIETIES OF FOOD-STUFFS.

(A) MILK.

Milk is the ideal food for infants upto 18 months of age and is equally useful in the other extreme of life ; but an adult requires nearly 9½ pints of it to satisfy his bodily needs. Like egg, cocoa and fat meat, milk is a complete food containing all the essential proximate principles. It is made up of casein (the proteid element), cream (fat), lactose (sugar), mineral substances and water.

(1) *New milk*, *full milk*, *entire milk* is that directly obtained from the udders of one cow. (2) *Market milk* is the mixture of several cows' milk sold in the bazars. (3) *Skim milk* is milk from which only the 'cream' has been removed, the entire proteid remaining. (4) *Butter milk* (*takra*) is cream from which the fatty matter has been removed. In it, the lactose has been in great part converted into lactic acid (hence the milk tastes sour) and the casein exists in a finely coagulated and therefore more easily digestible state. (5) *Condensed milk* is partially dehydrated milk. The following are the varieties of condensed mllk : sweetened or unsweetend whole milk ; sweetened or unsweetened skimmed milk. In the sweetened varieties, ⅛ by weight of *cane* sugar is added and the whole is reduced to ⅓ or ¼ by volume. Advantages of condensed milk : it is sterile and free from sourness. Disadvantages :—It is not antiscorbutic, it is fattening and constipating ; if very scantily used, for fear of using too much, it starves the child. Separated or skimmed condensed milk is not suited to babies, but is suited to adults. Condensed milk contains no preservatives.

Only full-cream unsweetened condensed milk should be used for children—the skimmed ones never.

(1) *Curdled boiled milk* (*dadhi*) is caused by acid fermentation (by streptothrix dadhi), and is made up of fat and proteid of milk. (2) *Whey* (*ghole*, *mastu*) is the solution left when milk is curdled (composed of lactose 4.45% salines and soluble protelds 1·24% but devoid of fat). When this action is fully developed, the casein may decompose into tyrotoxin. *Dadhi* is prepared by adding to milk some vegetable rennet (*e.g.*, aswagandha, halkasha, kharsan &c) or animal rennet or a little old dadhi. [The curdle found in the stomach by the action of gastric juice is soft and flocculent in the case of ass' and human milks, but dense and lumpy in the case of cows' milk. The amount of casein and of lime salts present in the milk as well as the degree of acidity of the stomach, determine the density of the clot. Clotting of milk is prevented by adding to milk, citrate of soda or by ærating the milk. (3) *Chhana* or *curd*—is composed chiefly of proteid (casein) and is the result of streptothryx action.

(1) *Cream* (*santanika*) or top milk—is the upper layer of raw milk which is rich in albumin and digestible fat ; it is obtained by standing the raw milk for 7 to 8 hours in a cool place when 70% of the cream rises. Its nutritive value is in proportion to the percentage of fat. Cream readily turns sour, but in this state also, it forms a special food. Warming and centrifugalizing hastens the separation of fat but does not increase it in quantity. Skimmed milk contains 1% fat, centrifugalized or separated milk only 0·3%. It is practically unknown in India. (2) *Shar* is the thin pellicle (casein + fat) that forms on the surface of boiled milk cooling down. It is not real cream. (3) *Butter** is the fat obtained by churning cream

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* *Margarine*, *Oleo-margarine* and *Butterine*—are prepared from lard, beef or mutton fat, cotton seed, sesame, earthnut oils &c. After mincing, mixing and melting them, they are churned with milk (to give flavour) and coloured with annatto. Though slightly less digestible than butter, they are of equal nutritive value with butter.

or milk or dadhi. Until repeatedly washed in water, it is mixed up with a little casein. *Navanitha* is the butter of fresh or scalded milk and *makhan*, of dadhi. [The nutrient value and the wholesomeness of all the animal and most of the vegetable fats are approximately alike].

Ghee (*neyi*)—is clarified butter. Its mode of preparation is as follows :—cows' or buffalo's milk is first boiled and then allowed to undergo lactic acid curdling (dadhi). This dadhi is churned and the fat (along with some casein) rises to the top. This is separated, washed in water and then set over fire when it melts--the brownish sediment representing burnt casein, the supernatant fluid, the ghee. If the heat applied be too severe, the ghee assumes an acid taste ; if too low, it becomes liable to putrefaction.

Cheese—is composed chiefly of casein and cream of milk. It is an exceedingly valuable, nutritious and economical food ; its nitrogenous content is twice as much weight for weight, as that of meat. If cheese is richer in casein and very compact, it is indigestible ; but the softer variety if used in small quantities, is very nutritious and promotes the digestion of other foods by reason of its flavour.

Comparative study of the Milks :—

		Buffalo.	*Woman.*	*Cow.*	*Ass.*	*Goat.*	*Mare.*	*Ewe.*
Sp. Gravity	...	1032	1027	1032	1026	1032	1035	1039
Water	...	81·40	87·40	87·17	89·60	85·71	90·79	75·22
Casein	...	6·11	2·29	3·55	2·25	4·30	2·00	8·83
Fats	...	7·45	3·81	3·69	1·65	4·78	1·20	11·28
Lactose	...	4·17	6·20	4·88	6·00	4·46	5·65	3·58
Minerals	...	0·87	0·30	0-71	0·50	0·75	0·36	1·09

Composition of Milk.—Milk is made up of—milk sugar, extractives, salt and PROTEIDS (*viz.*, lacto-albumin, lacto-globulin, nuclein and *casein*). None of these coagulates on boiling. [In the process of digestion, however, the rennet enzyme of stomach, breaks it up into para-casein, which, with calcium phosphate forms the *curds* and *whey-protein* which remains in solution; gastric juice breaks up the former into a phosphorized proteose, which latter is further broken up by trypsin into orthophosphoric acid and pseudo-nuclein.

The milk of the *sheep* (*ewe*) is rarely used as food by men; next to *buffalo*, *goat's* milk is the richest in solids, poor in butter-fat, is the most nutritious and the least digestible. *Ass'* milk is sweet and easy of digestion, but occasionally it gives rise to diarrhœa. It is best suitable to premature and feeble infants.

Composition, quantity and quality of cow's milk is influenced by a variety of circumstances, *e.g.*, (*a*) *Age*: Very young and old cows give milk of poor quality. (*b*) *Work*—Moderate work has no influence upon milk; but severe labour produces milk containing little fat and dry matter and excess of mineral substances. (*c*) *Rutting time*—produces rich and scanty milk that turns sour on boiling. (*d*) *Race and breed.*—The Multani, Guzrati and Bhagalpur breeds are superior to those of Bengal or Behar. (*e*) *Period since delivery.*—For nearly a month after delivery, milk is strongly alkaline and contains very little casein, much serum albumin and butter and is therefore purgative in property. The maximum amount of milk is often produced between the 4th and 5th calf and before the 8th week after each calving. (*f*) *The warmer the cow is kept* in winter, the greater is the yield of milk, within reasonable limits. During the rains, milk is thinner and during winter, thicker. (*g*) *Repeated pregnancies*—tend to deteriorate the quality of milk. (*h*) *Time and frequency of milking*—The first milk is watery; the oftener a cow is milked, the richer becomes the milk in casein; towards the end of a milking the milk is richer in butter; the evening milk is richer in butter than the morning milk. (*i*) *Food.*—A poor diet leads to diminution of solids; fresh green pastures produce the best flavoured milk; beet-roots and carrots increase the amount of sugar; odour, colour and poisonous properties of plants eaten are transmitted to the milk; a diet rich in proteids (*e.g.*, pease, beans, oats, maize, linseed, or decorticated cotton cake) conduces to milk rich in butter. (*j*)

Exercise.—A stall-fed cow that does not receive regular grooming or airing, gives very bad milk. [In India, milk, butter, cheese &c. are all cooked ; milk and its products are never kept as, or prepared from unboiled milk ; for, any temperature above 50·C will at once set up fermentation in India. It is well to remember in this connexion that even proximity to offensive smells will taint milk. *Sterilization or Pasteurization* of milk is secured by boiling and cooling the milk repeatedly.]

Bacterial Changes of Milk : The following "spontaneous" changes are the work of bacteria :—*Milk sugar* is converted into lactic acid ; *Casein* is coagulated with or without souring the milk ; poisons like *tyrotoxin* are developed in old sour milk without other appreciable alteration occurring in it ; *Putrefaction* is set up. Proteus vulgaris may change the casein into *bitter* peptones ; m. viscosus renders milk *ropy* ; b. butyricus coagulates milk and causes *butyric acid fermentation.* Some micrococci change the colour of white milk into *red*, *blue* or *yellow*.

Fermented Milk.—It contains all the solids of milk in very easily assimilable form and is therefore valuable to invalids. *Koumis* and *Kephyr* of Russia, *Leben* of Egypt, *Mazun* of Armenia, *Oxygala* of Rome, *Chiston* of Greece, *Rayet* of Algeria and Tunis, *Yoghourt* of Bulgaria and the *Dadhi* of India—are all fermented milks—appetising, cooling, antifermentative, stimulating and somewhat nourishing. They all depend for their formation on three factors inter-acting on the milk : (*a*) aerogenous streptothrix infection, (*b*) decomposition of the lactose into acid lactic and (*c*) curdling of the casein. [Normally, casein does not clot so long as milk is alkaline]. In some cases, as that of koumlss, alcoholic fermentation sets in, the older the stock is kept to mature.

Milk contamination.—Milk may become contaminated by germs transferred from (*a*) pus or purulent lesions of *udders*, (*b*) dirty *hands* or *pails*, (*c*) dung, dust or dirt clinging to the flanks, udders, tail or hindquarters of the cow, (*d*) unclean *water* used in rinsing the udders, the pail or the hands, (*e*) *straw*, *twigs* &c. thrown into the pail to prevent splashing of milk during transit, (*f*) dirty or exposed *sheds* in marts, (*h*) prolonged exposure near a place where organic matter is decomposing, as, in or near a stable.

Infectious diseases due to use of milk or milk products are sudden in onset, swift and severe in progress, and, abrupt in termination. *Ice-cream* and *kshir* (condensed milk) are dangerous articles of food in several cases.

Effects of Heat on Milk—(1) Boiling tends to *condense* the milk. (2) But boiling little short of making it solid does not completely sterilize it; short boiling may *kill some germs*; but, the moment the milk reaches the body heat, those germs that were inhibited during the boiling, become active. To completely sterilize milk, therefore, one must add sufficient water to it, and alternately boil it and cool it repeatedly and for some time. (3) Boiling reduces the anti-scorbutic properties of milk.

A short scalding or boil in open pans forms a thin pellicle on the top, called *Shar*, which is casein + fat, but is not the cream. Prolonged boiling condenses the milk (*Kshir*) while still further boiling, renders it solid (*Mawa* or *Khowa Kshir*). Boiling sweetened and starched milk over a slow fire, in a shallow vessel, with a fan breeze continually playing over it, produces *rabri* or *basundo* (shar + starch + sugar). Boiling does not reduce the nutritive value of milk. The imported *condensed milks* are produced in vacuo by gentle heat.

Rules regarding use of milk by invalids and children :—Do not use milk of a cow within 10 days of her delivery. Always use boiled milk. Reject milk of cows that are ill. Watered and skimmed milk is not to be used for babies. As milk imbibes smells easily, keep it away from them. *For children*, human milk is the best; because it forms flocculent, small curds which are easily digested; cow's milk forms, on the other hand, putty like curds which give rise to indigestion and colic. The proteid of human milk is ⅔ lact-albumin (which is not curdled by acids) and ⅓ caseinogen; in cow's milk, only $\frac{1}{10}$ is lact albumin and $\frac{9}{10}$ caseinogen. Addition of sod. citras (gr. 2 to 3 to each ounce of cow's milk) precipitates its calcium as a citrate and thus renders the clots light and flocculent. **Humanized milk**=Cow's milk so altered as to resemble human milk. To do this, water is added to dilute the proportion of casein, and sugar of milk and cream are added to make up for the dilution. *Whey cream mixture* (*i. e.*, skimmed raw milk+whey+lactose+lime water) contains lactalbumin and no casein and is therefore very well borne. CREAM is a sustaining diet. WHEY is useful in catarrhal and inflammatory states of bowels, in acute fevers and in chronic pulmonic and renal complaints. BUTTER-MILK is useful to weak stomachs and in cases of gastro-enteritis. It is also applied to erysepelatous areas. DADHI—is an antifermentative and easily assimilable form of milk ; it kills all pathogenic intestinal flora. It is also largely used (minus fat) in diabetes and being sugar-free is useful also in gout, and renal diseases. GHEE is an all-round ointment, specially when old. The use of ghee with rice stimulates pancreatic secretion. Prolonged course of PURELY MILK DIET is beneficial in kidney diseases ; this is specially so, if the milk is skimmed and its casein is in part removed by precipitation with rennet ; the kidneys in the latter case are spared the task of eliminating urea &c.

(B) ANIMAL FOOD.

It is divided into three groups—meat, fish, shell-fish.

(A) MEAT.

What it contains.—Meat consists of three substances: (1) **Connective tissue**—which, when boiled, yields gelatine ; (2) **Fats,** and (3) **Muscle fibres.** This last is the main constituent ; it, in its turn, is composed of three substances—(*a*) *nitrogenous* substances—myosin, muscle-albumin and haemoglobin ; (*b*) *extractives*—or chemical substances which have no nutritive properties, but which, by their aroma increase taste and relish ; and (*c*) *salts*—chiefly, chlorides and phosphates of potash.

What we eat.—We eat the flesh mostly of graminivorous animals. But, the flesh of almost any animal may be eaten without prejudice to health. As with meat we also get some bone and fat, meat-eating gives us—(*a*) *with the flesh*—proteid (chiefly fibrin), extractives, phosphoric acid, potash, and fat; (*b*) *with the bone*—gelatin, fat, salts. Three pounds of bone yield to soups as much carbon as one pound of meat and as much nitrogen as seven pounds of meat. **Amount of Fat in meat**—varies with different animals. It is *practically absent in* games and lean beef, *rich* in gramfed mutton and *richest* in bacon. The fat of *bacon* being granular is easily absorbed; that of *mutton* is heavy; that of *chicken* and *game* decomposes quickly.

Edible qualities of Meat.—The length and thickness of *fibres*, the *salts* present, the amount of *fat* as well as *extractives* present—determine the value of a meat. Hence, before slaughtering, look to—(*a*) the *species* the animal belongs to; (*b*) its *condition*—fat or lean, healthy or diseased; (*c*) its *age*—the very young and the very old being inedible; (*d*) the *sex*; and (*e*) the *part of the animal* best suited for particular peoples or forms of cooking.

Digestibility:—*Beef* is the most nutritious of all animal foods and fullest of the red blood juices, specially when procured from oxen well fed and four to five years of age. The flesh varies in quality according to the part of the animal from which it is taken. But beef requires stronger powers to digest than, say, mutton does. *Veal* is less digestible and less nutritious. *Mutton* is short-fibred, fat, very nutritious, easily digested (except by invalids with whom its fat disagrees). *Lamb* is less digestible than mutton and much richer in fat and poorer in nitrogen. *Goat* is short-fibred, less digestible than mutton, and is never attacked with tuberculosis. *Venison* (deer) is too stimulating for delicate stomachs. *Pork* being very fat is the most indigestible meat and on account of the pig being a foul-feeder, in some people pork gives rise to intestinal disturbances. *Bacon* consisting of granular fat is better tolerated. *Poultry* and *Games* as a class, are, slightly poorer in nitrogen and deficient in fat and iron but richer in phosphates; those with white flesh (fowl, turkey &c.) are easily digested but those with dark flesh (ducks, geese) are more difficult of digestion. *Hare* is as easily digestible as chicken but is more stimulating; *Rabbits* when old become difficult of digestion.

Digestibility of different parts: *Brain*, *tongue* and *tripe* (first part of ruminant stomach) being very fatty, and *liver*, *kidneys* and *heart* being close-textured, are difficult to digest. *Sweet-bread* (pancreas and thymus) and *calf's head* are useful for convalescents.

Edible qualities—how developed.—[The flesh of *youngs* of animals is not easily digestible and is less nutritious; for, in them muscle fibres have hardly developed—they being full of fat, water and connective tissue. *Ill fed*, *starved* and *old* animals' meat is tough, from degeneration of muscle fibres.] *Newly killed adult* animal—is unfit to be eaten until there develops in it sarcolactic acid and acid phosphates—both of which render the meat tender and add to its flavour. Hence, meat should be eaten after rigor mortis in it has passed off and before putrefaction has set in; for similar reasons, it is best to eat meat of hunted animals or of animals *bled after axing*. Bleeding before or after death improves the flavour and keeping qualities of flesh but renders it poorer in its iron content. Animals which are killed by lightning, drowning, smothering or apoplexy or are tired, exhausted or excited, overdriven or in a diseased condition, do not bleed well: their carcass tastes badly and decompose quickly. *Removal of male genitals* greatly improves the size and edible qualities of flesh (capon). It is injurious to take the meat of animals killed near parturition.

(B.) EGGS.

They are complete food: a hard day's work can be well carried on on eggs, bread, salt and water. The eggs of all birds have the same composition but their quality and flavour depend on the food of the bird which yields them. The **white** consists chiefly of albumen (which resembles, but is not identical with, serum albumen) and an excess of chlorides; the **yolk** contains twice as much proteid as fat and is rich in phosphates. The tendency of the white is to cause constipation. Boiling renders an egg indigestible.

II. FISH.

Its food-value :—It ranks as one of the most absorbed of foods—97% of its proteid, 95% of its salts and 90% of its fat is absorbed into blood. Compared with butcher's meat, fish is *poorer in* extractives and fat but *richer in* nitrogen and phosphates; hence, as a proteid food, fish is best suited to the old, the invalid and those who habitually eat but cannot tolerate an excess of meat. Except for its easy digestibility, fish is in no sense a *brain food* for sedentary brain workers. Chittenden, however, thinks that beef is easier digested than fish generally.

Its edible quality depends on : (*a*) *The season* : Fish is "in season" (*i.e.*, in perfect condition) just before spawning ; so too are the immature fish. During spawning, fish becomes thin and poorly and, in some cases, even poisonous. (*b*) *Feeding ground* : Fish of certain ponds and lakes are more palatable than others. Carnivorous fish are of better flavour than those eating vegetables. Flavour depends also on the quantity of fat a fish has. (*c*) *Length of time kept.*—Some are best eaten immediately after being taken out of water. "Cured" (*i.e*, salted, smoked, dried) fish is perfectly edible ; but if badly cured, it is supposed to give rise to leprosy. Fish diet has an aphrodisiac effect ; the bile of the rahu fish (Labeo Rohita) is a valuable medicine in the east as Cod Liver Oil is in the west. The hard roe (ovary) and the soft roe (spermatic organs) are alike delicacies.

Digestibility of fish : *Fresh water* fish are more easily digestible than salt water ones ; *white* fish more than red fish ; the *younger* more than the older one ; and the *less oily* more than those abounding in oil *e.g.*, the hilsa (Indian sable) and tapsi (mango fish). Fish that have *no scales* are generally regarded as unwholesome and indigestible. Cured, pickled and oiled fish are less digestible, though they contain the full amount of nourishment of fresh fish.

III. SHELL FISH.

They comprise the *Molluscs* (clams, cockles, mussels, oysters, whelks), and the *crustaceans* (crabs, lobsters, prawn, shrimps etc). These are highly nutritious but difficult to digest and, in some people, are apt to produce gastro-intestinal irritation or nervous symptoms. The **crustaceans** should always be eaten fresh or they soon decompose and rapidly become toxic. With some people, even fresh crustaceans disagree, causing urticaria etc. Oysters are eaten raw and are more easily digested. Those of Karachi are the best in India. **Mussels, Cockles** and **Oysters** collected from beds to which sewage gains access have been known to give the eater, b. typhoid, b. enteritidis sporogenes, b. cholera. Mussels often cause symptoms resembling those of curara poisoning even if eaten cooked (mytilotoxin).

Snail—is insipid, less easily digested and liable to cause poisoning, as snails feed freely on solanaceous plants. They are best eaten at the end of winter and always some days after their collection, so as to enable them to get rid of any poison ingested by them.

CHAPTER XII.

(C) VEGETABLE FOOD.

These are rich in starches and sugars but are by no means devoid of proteids and fats.

Animal Food.	**Vs.**	**Vegetable Food.**
It is rich in nitrogen, chlorides and soda.		Rich in starch, phosphates, potash, vegetable acids, water.
More easily assimilable, satisfying, stimulating, constipating.		Bulky ∴ taxes digestion; less assimilable, less satisfying, non-stimulating, laxative.
Cooking coagulates proteids ∴ it becomes less digestible.		Cooking ruptures starch granules, ∴ renders more digestible.
Suited to colder climates.		Suited to warmer climates.
Said to produce grossness of body and intellect.		No such thing.
Supplies sudden springs of energy.		Supplies sustained energy; but weakens resistance to disease.
Contraindicated in arthritic habits of body, with deficient elimination.		Contraindicated in flatulent dyspepsia and diabetes.

Constituents of Vegetables:—**The Proteids** of vegetables are richer in nitrogen and poorer in carbon; they are:—glutin, legumin, conglutin. Glutin is very easily assimilable and it does not exist as such in the grains, but is produced by the action of water on globulin and albumose present in the grains. The **Fats** yielded are variable; but they are perfectly edible, as, that of cocoanut. The **Carbohydrates** of vegetables are of three classes: starch, gums (dextrine) and sugar. (*a*) STARCH: It is composed of two bodies (*granulose* and *erythro-granulose* enveloped in a *cellulose* shell. The starch from each variety of grain has its characteristic appearance to indicate its origin. Some have even contour, (*e. g.*, arrowroot, bean, barley, pea, potato, rye, wheat), others are faceted (*e.g.*, maize, oats, rice sago, tapioca). Uncooked starch is difficult to digest; moist heat renders starch gelatinous and bursts the cellulose and swells the grain, rendering the latter better vulnerable to digestive juices. *Treated with iodine*, granulose turns blue, erythrogranulose, red and cellulose, yellow. **Cellulose** is the carbohydrate network protecting starch grains. It is resistant to solvent action of gastric juice but is decomposed by several forms of bacteria (*e.g.*, b. butyricus) present in the large intestines, where a large amount of nourishment is derived from it. When old, it becomes woody and indigestible. (*b*) GUMS or dextrines are white, odourless and soluble in water. (*c*) SUGAR —is the form of starch found in ripe fruits. The common sugars are *sucrose* (from sugarcane) and *glueose* (from grapes). It is as sugar that the carbohydrate circulates in the plant, starch representing the surplus and more concentrated form of carbohydrate stored up.

Classification of Vegetable Foodstuff.—They are grouped into six classes each with characteristic properties:—

A. **Cereals,** of which examples are:—rice, wheat, millet, maize, oats, barley, rye, buckwheat.

B. **Legumes'** which include—peas, beans and lentils.

C. **Roots and Tubers**—like potato, beet root, carrots, radish 'ole,' 'kachu', arrowroot, tapioca, cassava meal, 'sotee'.

D. **Herbs and Green Vegetables**

E. **Fungi**. F. **Fruits** and **Nuts**.

Of these, cereals, roots and tubers are richest in *starch*, fruits in *sugars*, herbs and green vegetables in *cellulose*, legumes in *proteid* and nuts in *fat*.

(A) THE CEREALS.—Are grasses whose seeds contain nutriment in a condensed form, their composition varying with the nature of soil and the treatment the soil receives. The portion of the seed next beneath the outer coat of cellulose is the richest in proteid and gets partly removed in the process of milling or decortication.

The following table shows the richness of each cereal in respect of its ingredients :—

Nitrogen.	*Fat.*	*Starch.*	*Salts.*
Wheat	Maize	Rice	Barley
Oats	Oats	Maize	Oats
Barley	Barley	Wheat	Wheat
Rye	Rye	Rye	Rye
Maize	Wheat	Oats	Maize
Rice	Rice	Barley	Rice.

Of the cereals, wheat and oats are the richest in nitrogen and poorest in starch and rice is poorest in nitrogen and richest in starch. The cereals furnish the staple food of all inhabitants of the globe ; but the preponderance of carbohydrates in them, while rendering them easily assimilable, necessitates the use, along with them, of fats and proteids in the form of dal, fish or flesh. The larger the percentage of proteid matter in the cereals, the larger is the proportion of the phosphates. Of the two varieties of Indian wheat, red and white, the former is richer in proteids. We consider each of the important elements :—

1. **Rice**—is the staple food in torrid Bengal. It is poor in nitrogen, fat and salts but is light, astringent and very easily and completely assimilable, on account of the small amount of cellulose that it contains. In the way in which it is taken in Bengal, rice is deprived of much of its nutriment in the three successive processes of (*a*) *parboiling* previous to husking, (*b*) *milling* to polish and whiten it and (*c*) *boiling* before serving. Rice should never be parboiled, never overmilled and steamed rather than boiled for eating. In this way alone, its salts, phosphorus-content, vitamine, starch and nitrogen can be made available and it has therefore to be taken with pulses

and peas as well as ghee). One ounce uncooked rice becomes in weight nearly 3 oz. by cooking.

[According to Sanskrit writers, the *best* class of grains includes—wheat, rice and barley only, other kinds being called "kshudra dhanya" or inferior grains. * There are hundreds of VARIETIES OF RICE in India. The *three principal ones* are (*a*) *Sali*, reaped in the cold season ; (*b*) *Vrihi*, ripening in the rainy season and (*c*) *Shastika*, grown in the hot weather in low lands. But, for practical purposes, we recognise two varieties only : (*a*) *old or new*, and (*b*) *country* or *Burma*. New rice, belonging to the last harvest, is rather difficult of digestion, while very old rice is easily digestible but less sustaining. The difference between country and Burma rice is that the former is parboiled (*i.e.* soaked in its husk for 30 to 40 hours, then steamed for 5 to 10 minutes, then sun-dried previous to husking) and retains some of its pericarp, while Burma rice is milled,—in which process, rice is fully deprived of its proteid and phosphorus-containing pericarp and reduced in size. *In Bengal, rice is used in 4 forms*—(*a*) boiled rice ; (*b*) unhusked rice parched in hot sand—*khai* ; (*c*) husked rice parched in hot sand—*moori* ; and (*d*) unhusked rice moistened, parched and flattened and afterwards the husk removed (*chipitaka*). *Rice is eaten as* : (1) Bhat—i. e, purely boiled rice with the gruel thrown away or not ; (2) *khichri*=a hodge podge of rice, dal and other vegetables and spices ; (3) *pillau*=rice boiled in a decoction of spices and ghee ; (4) *payas* or pudding (5) fried or puffed (*khoi*, *moori* etc). *In the case of the sick*, powdered rice is boiled with water and made of three strengths from semisolid to thin liquid.

2. **Wheat**.—It is the staple food of Europe, being rich in proteid (gluten) and in the phosphates of potassium and magnesium. From without inwards, a grain of wheat has these **structures** (compare them with an egg) :—(1.) OUTER

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* (1) Sorghum or joar, (2) Kangni (3) Shyama-dhan (9) Bajra (Ragi etc.)

SKIN (called '*bran*'* when removed) which is rich in cellulose and minerals. This is difficult of digestion but is laxative and nutritive, because it contains proteids. It forms 13·5% of the grain. (2). INNER BARK (PERICARP)—which consists of delicate scales which cannot be removed without tearing off the outermost layers of the kernel. This is nutritious and when ground down, produces the brown bran flour or *pollard*. (3) KERNEL OR ENDOSPERM—which grinds into fine white flour and is composed of chiefly starch with 10% gluten. This forms 85% of a wheat grain. (4). GERM or EMBRYO, forming 1½% of the entire grain, is rich in proteid and fat.

Composition of wheat.—(1) *Gluten* (which is made up of gladin, fibrin and mucin), (2) *Cerealin* which has diastatic properties, (3) *Starch*, *dextrin*, *cellulose*, (4) *Phosphates* of potash and magnesea. The nutrient ratio is 1 : 5, nutrient value, 84.

Out of a grain ground 80% is flour 16% is bran and 4% is loss. Bran is rather indigestible unless very finely powdered and is a good laxative for the constipated and bone former to the ricketty; its exclusion means a loss of 15% proteid 3·5% fat and 5·77 salts. In the process of milling a large portion of fat and minerals is lost.

Nomenclature of wheat products :—(1) *Whole wheat meal* =bran, pericarp, kernel and germ—all ground down. (2) *Decorticated whole-wheat*=every part except bran ground down. (3) *Bran*=removed outer skin of wheat grain. (4) *Pollards*=coarse powder of the fine bran or pericarp. (5) *Flour*=kernel and germ ground down. This when coarse grained and derived from outer (proteid) layer=*Sooji* (13 to 16% proteid); the finer grains derived from middle layer

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* Bran contains a ferment, *Cerealin*, which aids digestion.

=*Atta* ; and the finest powder, derived from the innermost layer=*Maida* (10·1 °/° proteid).

Preparations of wheat :—Loaf or bread, biscuits, pastry, cakes &c., macaroni, vermicelli, Italian paste, semolina—are all forms of wheat flour rich in gluten.

1. Bread.—If flour (kernel and germ) is mixed with water, it forms a sticky mass called *dough*.[†] The stickiness is due chiefly to the glutin present. When this dough is ballooned up by CO_2 into a spongy mass, we get the Bread. The ballooning is done—

(1) IN THE FERMENTED[‡] BREAD—by mixing with the dough (*a*) *Yeast*—which first changes part of the starch into sugar and the sugar into alcohol and CO_2. The CO_2 swells up the dough into a spongy mass. When the dough is put into the oven at 450° F, the yeast are killed and further CO_2 formation is checked, and most of the alcohol formed is evaporated. (*b*) *Sour yeast*, (*c*) *Leaven* or *sour dough*—in which cases, the fermentation is imperfect and the bread tastes sour.

(2) IN THE UN-FERMENTED BREAD.—(*a*) *CO_2 gas* is driven by force into the dough, (the Dauglish's process) ; or (*b*) the

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[†] The amount of *gluten* (=gladin and mucin and fibrin) present determines the formation of dough ; hence flours poor in gluten cannot be made into light bread. [If dough is continuously rubbed and washed over a sieve, the starch falls to the bottom and the white sticky gluten remains above]

[‡] *Advantages of Fermentation* :—Some of the starch is changed into maltose and dextrine and some of the proteids into albumoses or even peptones. *Disadvantages of non-fermentation* : the daily use of chemicals tends to upset digestion. *Advantages of Aerated bread* : (*a*) Fermentation and chemicals are absent (*b*) cleanliness, uniform swelling and better keeping qualities for the bread. (*c*) suited to delicate stomach.

various *baking powders* (=an alkali + an acid) are mixed with the dough to generate CO_2 inside it. (*c*) *Butter-milk*(=lactic acid) + soda bicarb also serves the same purpose.

A good bread—should be well baked (not burnt), spongy, not acid, nor bitter to the taste and not too moist, not sodden in its lower part.

BREAD DISAGREES IF—(*a*) the flour is old or adulterated ; (*b*) the yeast, being bad, ferments too rapidly, or, owing to cold weather, ferments imperfectly ; (*c*) the fermentation going on overmuch, produces lactic, butyric &c. acids. With some people, the fermented bread always disagrees. (*d*) *New bread* is more palatable but less digestible than stale bread, because it forms lumps on mastication. Newly made bread should not be eaten before the lapse of 24 hours. Kept for sometime, the moisture of starch is transferred to gluten—hence, crust becomes softer, crumb drier. Addition of barley, oats or maize causes the bread to appear dry quickly. Potato flour yields moist bread. Milk, malt extract, the germs of the wheat and crushed remnants (1 °/₀) of old bread are mixed up with old dough. If the old fragments are not mouldy, this is not unhygienic. Bread not properly fermented is watery and grows hyphomycetes and spores of bacteria and become harmful. (*e*) *Toasting* renders bread easily digestible ; but when cut too thick and kept too long after toasting, or, when saturated with hot melted butter, it disagrees. *Fine white bread or roll* is the most digestible of all.

2. **Biscuit**=baked unfermented dough. It keeps long and is wholesome. Three pounds of biscuit are equal in nutritive value to 5lbs bread.

3. **Chapatees** are circular, thin, non-aerated, unleavened hand made breads used in India. They are fried dry (*roti*) or in ghee (*loochie or pooree*). When fresh, they are easily assimilable and nourishing. Five ounces of atta correspond nearly with $7\frac{1}{2}$ oz. dough and $6\frac{1}{2}$ oz. of chapatee.

4. **Halooa**—is a rich sweet preparation of sooji in ghee and is productive of acidity.

5. **Sweetmeats** are mostly preparations either of chhana or of dal or of flour with sugar and ghee.

3. Millet and Buckwheat. [Great Millet = sorghum, *juar*; Indian millets =. *Bajra* or bulrush millet, *ragi*, chena; Buckwheat = brank, *phaphra*]. After rice, sorghum is perhaps the most valuable single article of food in India, being rich in proteid, fat, silica and phosphates. The buckwheat is not much used as food in India, except occasionally, at high altitudes, for, being excessive in cellulose, in the process of decortication, it loses 20 % of its weight; the nuts are ground into flour and made into *bread* or eaten as *porridge*; its leaves and shoots are boiled as a spinach.

Maize* (Indian Corn, Mealies; *Makai*).—It is highly nutritious, but poorer in glutin (∴ cannot be made into bread) and in cellulose but is richer in fat (hence, very liable to become rancid or mouldy) and is a staple article of diet with aboriginal tribes of the hilly tracts of India, who either roast or boil it when green, or parch it when ripe. In upper India, the grain is ground into flour (or *chhatu*) and made into bread or eaten as porridge. *Chha tu* (*Sa'ttu*) is the pulverized parched maize grain mixed with barley flour; this starchy stuff is sold in Europe and America as Hominy, (rich in proteid), Maizena, Polenta or Oswego or Indian cornflour. [Thus, **cornflour** is mainly the starch of maize, as, much of the proteids and fats are removed in the process of treating it with caustic soda].

4. Oats (*Jai*.—Rarely used by Indians as food but extensively used as gruel, cake or porridge by the Scotch and other north English people. The oatmeal is rich in proteid, fat and minerals but deficient in gluten. It is the most nutritious of all cereals. Oats rolled and heated during rolling, are more digestible than ground oats. Oat grains have two or three envelopes enclosed within a husk. '*Oatmeal*' = ground kiln-dried grain deprived of its husk. '*Groats*' or '*grits*' = oat-seeds deprived of their outer integuments. '*Oat flour*' = oatmeal minus branny envelope. '*Quaker Oats*' = oat grains rolled (instead of being ground) with the application of heat. Oatmeal is slightly bitter and laxative and unsuited to gouty people as it increases the formation of uric acid.

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* Characteristics of the Grains of Starch of: Rice—faceted, no hilum. Oats—faceted, no hilum. Maize—faceted, distinct hilum.

Barley (*Yava*). *Barley meal* = whole-grain ground. *Scotch Barley* = ground grain minus husk. *Pearl barley* = polished grain minus husk. *Patent barley* = pearl barley ground to flour. Compared with wheat, barley contains less proteid and no glutin but more fat and minerals (iron and phosphates). The Romans and Greeks trained their athletes on barley and the Hindus class it as one of three best grains. In India, the seed is pounded in wooden mortars and winnowed and then ground into coarse meal. *Chapatees* made of this coarse meal, mixed with the meal of wheat or gram are eaten. The grain thus used is richer in albuminoids than the imported ones, though more indigestible. By the germination of the barley grain, **malt** is produced, owing to the action of the ferment diastase upon the carbohydrate.

(B) **LEGUMES OR PULSES**:—These are called vegetable beef and on them alone men and animals can subsist for long periods. These seeds are rich in proteid (mostly legumin or vegetable casein) and, hence, are difficult of digestion. They are poor in fat and starch, and are heating and stimulating. Being rich in purin bodies, they should be avoided by the gouty. They are divided into **three classes**—Beans, lentils or *dals* and peas. **Peas** and **Beans** contain, in addition, sulphur and calcium and potassium phosphates, and are likely to give rise to flatulence; they are both deficient in sodium chloride. *The starch grains* of peas and beans are oval or kidney-shaped, devoid of hilum and possessed of a central longitudinal cleft or irregular depression. **Lentils** are the most nutritious of all pulses, being poor only in fat; they are rich in iron and calcium phosphate and do not contain sulphur. All pulses have to be taken along with fat or bacon and with cereals poor in proteids like rice or potato. Thus, gram, ghee and rice furnish a complete food. The green ones are taken raw or cooked, while the dried ones have to be at first husked and then very slowly boiled long before being taken.

Green mung-ká-dál (phaseolus trilobus) being light, is almost the first Indian diet in convalescence; *masura* (ervum lens), *chanaka* (cicer arietinum), *kulaththa* (dolichos biflorus) and *makustha* (phaseolus aconiti folius) are similarly used. *Masura* is astringent to the bowels and antigalactagogue when used as a poultice to the breast. *Másha* (phaseolus) and *kulaththa* are galactagogue and the latter is diuretic and antilithic and is used in paralysis, rheumatism and nervous affections. *Arhar*, *Kalai* and *Masur* being heating, are forbidden to widows. *Matar* (pisum sativum) is used during mourning. The vitamine content of *mung-ká-dál* makes it specially valuable. [Revalenta Arabica, Revalesciere, Ervalenta—are foods which contain lentil-flour, pea-flour, bean and maize-meal, with probably oat and barely-meal].

(C) **ROOTS & TUBERS**—represent the starch reserve of the plants. They are rich in starch, cellulose, mineral matters and water and poor in proteids and fats. They are, therefore, valuable antiscorbutics and should be supplemented by proteids and fat. The principal ones are :—

1. **Potato.**—It belongs to the same *natural order* with belladonna or tobacco and contains (specially, when young, unripe or spouting) a trace of the active principle *solanin*,

which is destroyed in cooking. The presence of free citric acid, potash salts and alkaline citrates makes it a valuable anti-scorbutic. *Asparagin*, though not itself nutritious, is an aid to the assimilation of other principles. Supplemented by a nitrogenous food, life and vigor can be long sustained on a liberal diet of potatoes alone. Being too much starchy, specially when new, it causes flatulence and disagrees with weak stomachs. According to von Noorden, potato starch is peculiarly well adapted to replace other starches in the diabetic's diet. *Its starch** has large oyster-shaped granules, with well-marked concentric rings and a clear, small hilum at the narrow end. It is cooked with or without its skin on being steamed, boiled, baked or fried. Baked potatoes are less nourishing than those boiled in their skins. Heat coagulates the albumen and if boiled, dissolves out the albumen and swells up its starch grain ; but, when baked in its skin, converts the starch into a soluble form and finally into dextrose. When the starch cells are completely broken up, the potato is said to become *mealy* or *floury*; when imperfectly or partially broken up, *close* (firm), *waxy* or watery. [Potato flour, English arrowroot, and various children's foods, all consisting principally of starch of potato, are of far less nutritive value than they are represented to be]. FARINA is made from the starch of potato or maize.

2. Sweet Potato.—(Batatas edulis) contains more dry starchy and sugary matter (1½ to 2% cane sugar) and less proteid than ordinary potato. When boiled, it is more digestible than if eaten uncooked.

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* The "eyes" grow at the expense of the starch. Also, on keeping long, its starch becomes converted into sugar ; if however, it is removed to a room not artificially heated, the sugar is destroyed and the taste becomes normal again.

3. **Carrot root**—contains oil, sugar, pectin, nitrogenous compounds. It is not much used as food, though in famines, these roots may be resorted to.

4. **Beet root**—is used as a vegetable for salads, being rich in sugar.

5. **Arrowroot**—formerly derived from the tuber or rhizome of maranta arundinaceæ is now the starch of *a great variety* of sources. But, honestly speaking, it should be the starch of a-year-old root of one of these 4 :—Canna, Curcuma, Maranta, Tacca. It is pure starch and has very slight nutritive properties. "*English arrowroot*" is potato starch.

6. **Sati** (curcuma zedoaria) as sold purified—is pure starch with decided demulcent and astringent properties.

7. **Tapioca.**—The root of manihot utilissima is scraped and reduced to pulp; the coarse meal obtained by drying and pounding this is called *Couac*; *Cassava* is couac of greater degree of fineness; *Brazilian arrowroot* is the starch washed out of this root; *tapioca* is the same slightly parched. [All the cassava plants contain a glucoside which has the property of liberating free HCN; eating the roots raw causes poisoning; but, fortunately, boiling the root causes all this glucoside to pass into the water, leaving the starch free.

8. **Sago**—is the pith of the stem of various species of palm. It is easily digestible and slightly nutritive, specially when added to proteid foods (milk, soup &c.).

9. **Kachu** (Colocasia Antiquorum, Egyptian Arum), and **Ole** (Amorphophallus campanulatus, Elephant's Foot) are tubers rich in starch and oxalates,—ole being credited as valuable in piles. **Rat-tailed radish** (mula) is more of the nature of a green vegetable and contains a sulphureous oil.

(D) HERBS AND GREEN VEGETABLES.—They are prized for their salts, cellulose, acids and antiscorbutic properties. Some of these are bitter, others are acid or pungent, still others are of agreeable flavour and taste. Some are prized for their diuretic, hypnotic or other medicinal properties. To vegetarians, they are source of carbohydrate supply; to diabetics, as carriers of fat; to those who are gouty or with stones, as diuretics. The mass of cellulose eaten as vegetables not only stimulates peristalsis but much of it also undergoes bacterial digestion in the large intestines, producing organic acids, which, in combination with bases are readily absorbed into the system.

CABBAGE contains too much sulphur; CAULIFLOWER—contains less sulphur and more protein and is therefore easily digestible. ONIONS and ASPARAGUS contain a large amount of phosphates and are laxative. [As green herbs eaten raw may transmit cholera, dysentery, worms &c., use only such green vegetables as have been grown under personal supervision and carefully washed before use. Salads are highly antiscorbutic but indigestible].

(E) **FUNGI**—are among the lowest forms of vegetable life; they contain a large amount of nitrogenous matter but are rather difficult to digest. Not all fungi are edible, some of them being positively poisonous. The mushrooms, morels and truffles are often believed to be safe.

(F) **FRUITS—when ripe** are prized for their agreeable and appetising tastes and flavour and for their salts and sugars in varying proportions. They are also valuable antiscorbutics. They are cooling, refreshing, wholesome, agreeable and somewhat nourishing. Broadly speaking, the *drupes* (stone-fruits) are nourishing, the *pomes* relaxing, the *berries* diuretic, nourishing and laxative. No fruit can sustain life for long; but the juice of ripe dried grapes, the pulps of the mango, jack fruit, bael, papaya, banana &c. contain considerable nourishment in the shape of starch, dextrine and sugar and may thus be considered to be a food to some extent only. Bedana (pomegranates) and oranges contain only a very scanty proportion of sugar and possess hardly any food-value. Water-melon, like cocoanut, bedana and oranges, furnishes a cooling drink. The bread fruit of Polynesian islands takes the place of rice or wheat in other countries. In their **unripe** state, most of the fruits contain an excess of tannin and fruit acids, which cause irritation of the bowels and of stomach. In **over-ripe** fruits, the flavour, the sugar and other principles disappear.

(G) NUTS—Date, walnut, apricot, pistachio, cashew nut, ground nut &c. are rich in fat, proteid and cellulose and therefore are rather difficult of digestion though very nourishing.

CHAPTER XII.

FOOD ACCESSORIES.

All food is not acceptable to the taste or to the digestive capacity of man ; it becomes, thus, necessary by supplementing the food, with certain stuffs, to render the former pleasing to the eye, nose and palate. The effect of this is (*a*) to excite reflexly salivary and gastric secretions, (*b*) to excite circulation and thereby keep up a healthy supply of the digestive secretions and thus indirectly (*c*) to aid the bodily nourishment. Thus, though these additional stuffs neither give heat nor form flesh, and, therefore, are not in themselves true foods, they are a necessity of life. These accessories of food are divisible into two groups—beverages and condiments.

(A) BEVERAGES.

The beverages or drinks used are either aqueous, alcoholic, alkaloidal or antiscorbutic.

AQUEOUS : These are in demand in hot climates and comprise ordinarily five items :—

(*a*) **Pure water** forms the greatest bulk of every good food and drink as well as of the human body ; hence, even if we do not drink water separately, we imbibe a large quantity still. Water does not remain more than an hour inside stomach—hence, any bacterially infected water rapidly gains access into the intestines and thence into system. COLD WATER, taken on an empty stomach, causes catarrh of stomach and reflexly depresses heart, specially when it is *quaffed off after exertion and heat* ; *slowly sipping* a drink has stimulating effect on the circulation. It is wrong, specially for a vegetarian and a rice eater, to drink too *much water with, or within 2 to 3 hours after a full meal*, because, by diluting the gastric juice, and by overstretching the walls of the stomach (and thereby impeding the gastric movements), digestion is retarded and fermentation is aided—leading to acidity, indigestion and other troubles. It is best, therefore, to drink only a few small sips at, or within a few hours of, a meal. Those who do not masticate their food well, or those who eat long after they are actually hungry—they it is that feel thirsty at meals. If it is bad to drink too much water, it is equally bad *not to drink* any water in the 24 hours ; for, the latter causes constipation and leads to urinary irritation. The ideal rule regarding drink is, to take slowly, in sips, a few (8 to 10) ounces of HOT water on rising in the morning, as well as late in the afternoon —on both occasions on an empty stomach. This washes the stomach of food debris left by the last meal and presents a clean surface to the next meal and does away with the necessity for further drinks at meals.

(*b*) **Aerated or sparkling waters,** Aqeous solution of CO_2, with or without the additions of various flavouring or sweetening agents. Ordinarily, water can absorb, under pressure, five times its volume of CO_2. Ærated waters contain only CO_2 at a pressure of seven atmospheres. Real "Soda water" = 30 gr. sodii bicarb + CO_2 in water. Potash water is of identical make. So-called 'Soda water' does not contain any soda. The MERITS of the aerated waters are: (*a*) they soothe the mucous membrane of the stomach; (*b*) they expel gas; (*c*) they slightly stimulate gastric secretion; and (*d*) added to acid wines, they diminish acidity of wines. Their DANGERS:—As aerated waters may be made from questionable sources of water supply and sweetened with impure stuffs contaminated with lead or arsenic, they may give rise to gastro-intestinal disturbances, unless of guaranteed purity, for, except the comma bacillus (which is only rendered paralysed) many other germs thrive in CO_2. When added to milk, it curdles milk into fiocculi.

(*c*) **Mineral waters,** so-called, may be water from hot springs (as that at Sitakundu) or water from artesian wells, which as a rule, are bacteria-free.

(*d*) **Sherbets**—are solution of sugar or fruit juices or liquefied pulps of fruits, or whey; they are very much used in India. They take off fatigue, are refreshing, and have nutritive, appetising, laxative and antiscorbutic properties.

(*e*) The water inside unripe **cocoanut** and ripe **water melon,** the fresh juice of **date palm tree** are nature's own beverages, not without food and medicinal properties. Cocoanut water is faintly acid, of Sp. gr. 1020 to 1030 and contains —CO_2 (98%), oxygen (0·2%), nitrogen (0·3), sucrose, a proteolytic diastase, oxydase, catalase, lypase, amylase, peroxydase. The water of unripe cocoanut alone is fit for drinking.

ALCOHOLIC. Alcohol is of **three kinds**—(1) *Amyl* or that obtained from fermenting grains ; (2) *Methyl* or wood naphtha or Pyroxilic spirit obtained from destructive distillation of wood ; and (3) *Ethyl* or ordinary alcohol; obtained from saccharine liquids by the growth of yeast or ferment. Ethyl alcohol has been **prepared from** rye, wheat, barley, rice, maize, potatoes, molasses, bananas, apples, chicory roots, peat, straw, currants, oil cakes, sawdust. That obtained from grapes is called *wine* or brandy ; from molasses, *rum* ; from corn, *gin*, *hollands*, *whisky* : from potato, *fusel oil*. *White* wines are prepared from the 'juice' of the grapes and *red* wines from the 'whole' grape.

The **strength** of the various alcoholic preparations are (in terms of actual amount of alcohol present) :—DISTILLED SPIRITS :—Absolute Alcohol—99 ; Rectified spirit—90 ; Proof spirit or spt. tenuior, 49 ; Brandy, Liqueurs, Gin, Rum, Whisky, 'arrak'—48 to 56. [*Spirits*—are produced by distillation of alcohol from fermentation of various saccharine or starchy materials. *Liqueurs*—are preparations of distilled spirits, flavoured with fruits, spices and aromatic substances.] FERMENTED WINES :—Southern wines (Madiera, Malaga, Marsala, Port, Sherry)—14 to 18 ; Burgandy, Champagne, Hungarian wines—10 to 13 ; Claret, Hock, Sauterne or Moselle, red or white French wines—8 to 11. [*Wines* (*natural*) —are produced by fermentation of grape juice. *Sparkling Wines* are those which have undergone a secondary fermentation of added sugar. *Fortified wines* are those in which spirit has been added to prevent further acetic fermentation. *Dry* wine is non-sweet wine. *Plastered* wine is one which has been treated with gypsum to clear it, and which in consequence has been deprived of its tartrates.] MALT LIQUORS :—Ale, Beer, Cider, Lager Porter, Stout, 'toddy', 'pachwai', 'handy'—3 to 5 or more. [*Malt Liquors*—are prepared by fermentation of malt and hops. *Country liquors*—are prepared from fermentation of juice of fan palm, rice, mohua juice (bassia latifolia), molasses, cocoanut, bastard date &c.]

Dietetic Classification of wines :—

(1) *Spirituous* or *Liqueur Wines*—which contain more than 15% alcohol, are either (*a*) *dry—i.e.* sugar-free or (*b*) *saccharine* or *cooked—i.e.*, retaining some sugar. These are taken by invalids during convalescence. (2) *Red* or *astringent wines* which contain tannin; *e. g.*, Claret, Burgandy, Bordeaux. (3) *White* or *acid wines*—contain less tannin and more free acid. These are diuretic and best taken with alkaline drinks. (4) *Sparkling Wine*—is stimulating to the system and soothing to the stomach.

[(*a*) *Spirits*—make man boisterous and aggressive. (*b*) *Wines*—they contain ethers, ∵ excite feelings, thought and emotions, whose effects are confined to the individuals themselves. Wines also contain sugar (½ to 2 %) and bitartrate of potash; light wines are therefore antiscorbutic. The amount of fruit sugar (per ounce) in :—sherry, 8 gr., madeira, 6 to 66; port, 12—28; champagne, 24 gr. (*c*) *Brandy*—when prepared from vines by distillation is the purest and the least injurious form of spirit; it stimulates gastric secretions and expels wind from the stomach and when it intoxicates man, it makes him more gay and less furious. That prepared from silent spirits is no good. (*d*) *Whisky*—if new, contains much fusel oil, which has a powerful and injurious action on brain; if aged over at least 2 years, the oil is converted into aromatic ethers. When made in pot stills, it is called Malt whisky; when in patent stills, Grain whisky. (*e*) *Gin*—is diuretic. (*f*) *Beer*—has a tendency to cause sleep and has slight food value, because it contains carbohydrate, proteids, minerals and vegetable acids. Its caloric value is the same as that of milk. If taken in excess, it leads to retention of waste products, superfluity of fat accumulation and retardation of digestion. Beer tends to produce gout and rheumatism. (*g*) *Rum*—has slight astringent effect or gastric and pulmonary tissues. (*h*) *Port*, *Hock* and sherry—produce gout.]

Is alcohol a food ?—A food (*a*) *builds* up tissues, (*b*) *repairs* waste, (*c*) *saves* waste of tissues, (*d*) *furnishes* heat and force to the body without causing injury to any part of the body or loss of its functional activity. But, alcohol, *instead of producing energy and strength* (like a true neuro-muscular stimulant), merely makes a man draw more rapidly upon his own resources : hence, it is avoided by the soldiers in campaign and better brain work is done without it, than with it. (*b*) Though by its oxidation, *slight heat* is produced inside the body, alcohol causes a greater dissipation and loss of heat ; thus, the feeling of warmth and glow is created more at the expense of the internal heat of the body, than by its own oxidation. (*c*) Alcohol, even ale, has practically *no nutritive value*, the adiposity of alcoholics being due to conversion of muscles into fat and diminished oxygenation of blood causing decreased fat metabolism. (*d*) Alcohol, specially in those unaccustomed to it, *causes increased nitrogenous waste.* Alcohol, thus, is not a real food; though, theoretically, it is a carbonaceous food, and a very inconvenient one. For, *it will not support life* when given alone, but will help to do so, if given along with other food. But apart from these theoretical considerations regarding *pure* alcohol, we must look upon alcoholic *beverages*, with their flavour and boquet, their taste and body, as distinctly appetising, stimulating to digestive juices and gastric movements and thus valuable accessories of food, provided they are taken in moderation. The Hindu system of treatment never looks upon alcohol as a food but as a medicine in convalescene in fevers and in phthisis.

Rules against use :—A *child* should never take alcohol nor should a *youth.* An *adult*, who is not receiving nourishment fully, may take it in moderation, only during the period of under-feeding. Wine is the milk of *old age*—but old men with tendency to over-weight and obesity, should not touch alcohol. The habit of pegging (drinking in small frequent doses) before meals is the worst form of taking alcohol. Taken during bitter cold, alcohol proves fatal. Taken habitually in excess in tropical climates, alcohol is injurious. Though a regular dose of 1 oz. of whisky in 24 hours in the temperate climate may be allowed, it had better be avoided in the tropics. It should be avoided—during prolonged, hard bodily or mental exertion, during very cold weather, in gastric catarrh, by those with atheroma, kidney or liver disease, or glycosuria, by those with tendency to entiritis or bronchial catarrh, on empty stomach or during fasting. It is absorbed unchanged into the blood within fifteen minutes of ingestion. In the form in which it is taken (*i.e.* diluted and in small quantities) it has no anti-microbic action inside the alimentary canal.

Rules for taking alcohol : (1) In 24 hours one should not take more than 2 oz. of absolute alcohol (=4 glasses port, or 5 glasses sherry, madeira or marsala, or ½ to 1 bottle of claret, burgandy, hock, moselle or Hungarian wine). (2) While a small amount drunk with meals, stimulates gastric secretion, a large amount has the opposite effect. (3) Those who have weak will or strong emotions, should avoid it, as they are liable to form habits. (4) If the stimulant effect is desired, alcohol should be drunk raw (undiluted). (5) Drinking in sips stimulates, but in one gulp inhibits the action of the heart. (6) In acute fevers, convalescence and consumption, alcohol is beneficial (7) For those taxed with care and worries of business, the best time to take alcohol is after the day's work is done, when alone alcohol checks tissue waste and change advantageously.

Evils of Drinking : *To himself:* It gradually shortens life, lessens reproduction, increases criminality and dipsomania and leads to hallucinations in some, delirium, insanity, epilepsy and dementia in others. (Vide Author's Jurisprudence). *To his offspring* a drunkard transmits—gout, scrofula, tubercular meningitis, epilepsy, convulsions, excessive sensitiveness, abnormal reflex excitability, irritable temper, lack of power of application, arrested intelligence, idiocy, craving for alcohol.

ALKALOIDAL. These comprise beverages whose active principles are alkaloids and include tea, coffee, cocoa, coca leaves, kola.

1. **Tea**—is the dried leaf of the plant *camellia thea*, which grows in China, Japan, Ceylon, India (Assam and Darjiling specially). **Classification :** *Paraguay tea* and *Guarana tea* are almost identical chemically with ordinary tea ; only, they contain more caffeine. Tea is of two *kinds*—(*a*) Green or Black. *Green tea* is prepared by firstly allowing the fresh leaves to ferment for twelve hours (so as to render the tannic acid less soluble) and then by drying them slowly over charcoal fires. *Brick tea*—is a compressed mass of tea refuse, broken leaves and twigs. This is powdered and mixed with fat, salt and roasted meat and is eaten by the Turks. *Lie tea* is no tea at all ; it is the dust and sweepings of the warehouse, cemented with rice and rolled into masses. *Digestive tea*—is tea in which the tannin has been deprived of its power of precipitating gelatin by electrical treatment. **The varieties** are usually three—all tea being grown from the same species of the shrub. The bud and top leaves (the least fibrous and the most succulent) are called *flowery* or *orange pekoe* ; the two or three larger leaves growing on the same twig a little lower down,

constitute *pekoe-souchong*, while those below form *Congou*. Some teas are SCENTED in China by mixing the leaves with odours of flowers (orange, rose, jasmine &c. The different QUALITIES of tea depend on mixing (blending), age of the leaves and the soil. The **physical appearances of** tea leaf are: Shape—elliptical; margin—serrated almost to the stalk; top—notched; a central midrib gives rise to alternating veins, the latter not reaching the margin but turning towards the midrib and anastomosing with each other.

Composition OF DRY TEA (per cent.) Water 7. Ash 5·4 Dextrin 9·7. Theine or Caffeine 1·8 Albumen 2·6. Tannic Acid 15. Cellulose 22 Extractives 20. *Tannin* is very soluble in water; hence it is impossible to avoid it even in the shortest infusion; and the longer the leaves are infused, the more tannin will dissolve out. The Indian tea, green tea and all cheap teas are particularly rich in tannin. Green tea and fresh new tea contain the largest amount of *volatile oil. Theine* is chemically identical with caffeine and is rich in nitrogen, there being 1 part of nitrogen in 3·46 parts of theine. The amount of *gluten* present in tea remains in the leaves, not being extracted in the infusion. The addition of soda or lime dissolves it out and the Tartars extract it. **Mode of preparation.**—(*a*) Tea (fine black) *infusion* is made with water that is neither too hard nor too soft and has just come to a boil. The leaves, or better still, powder of leaves, should be infused for a minute or two, the same leaves never being used again. [Prolonged infusion lessens the aroma and dissolves out more and more tannin. Soft water extracts more from tea than hard water does and its use is therefore economical.] (*b*) Boiling the tea, (*decoction*) as done in cheap tea houses, is injurious and extracts too much of tannin. (*c*) The Chinese use a short infusion of *green* tea, thereby avoiding much of the tannin. **Actions of tea.**—Of the four important constituents of tea, the *volatile oil* is narcotic ; it also causes headache, giddiness, tremors or wakefulness (irritation of the nervous system) ; *theine* (*caffeine*) arrests or diminishes waste, thus lessening the necessity for, and taking the place of, food ; *gluten* which remains in the leaves is nourishing ; and *tannin* is astringent. But the combined action of all these is different from any one of them considered apart. Tea soothes and at the same time exhilerates (without subsequent depression) the vascular and nervous systems ; it removes fatigue, rouses and clears the mind, promotes intellectual energy and diminishes tendency to sleep. Taken hot, it is a diaphoretic. It removes headache. It cools the body when hot and *vice versa*. It is diuretic and deadens appetite and therefore increases the power of fasting. It is with some persons an aperient. Its tannin has inhibitory effect on peptic and salivary digestions. [Green tea overexcites the nervous system]. **Abuse of tea leads to**—indigestion, sleeplessness, muscular tremors, neurasthenia, cardiac insufficiency. **Avoid tea**—while fasting or with any kind of food specially that rich in nitrogen (meat, egg).

2. Coffee—is the berry or seed of the plant *caffea arabica*. It is cultivated in Arabia (Mocha), Ceylon, Malabar, Jamaica and the West Indies. **It is eaten**—raw in Arabia but in civilized countries, the beans are roasted, ground down and then infused in nearly boiling water. In Europe, they use an infusion, in the East, a decoction for about 2 to 5 minutes —the latter preserving the nutritive and tonic properties of coffee. The addition of alkali to the water is economical. **The composition** of raw bean is :—fat 12·27, legumin 12·07, sugar 8·55 (dextrin), vegetable acids, mineral salts 32·71 aromatic oils, caffeine 1·21, tannin, 32·79. But when roasted, sugar and dextrine become caramel, aroma develops and caffeine becomes dissociated from tannin. **The actions** of coffee depend on its aromatic oil and caffeine. Like tea, coffee has an invigorating (without any after-depression), restorative and sustaining power; but it is more stimulating and exciting to the nervous system, causing, in some persons, specially after excessive drinking of it, wakefulness, nervous excitement, tremulousness, slow intermittent pulse. To some it is a laxative, to others astringent; it is diuretic but has no diaphoretic action; on the contrary, it induces a dry, hot skin. It increases the CO_2 output of lungs and urea elimination, ∴ it decreases nutrition. It does not so powerfully interfere with salivary and peptic digestions as tea does, but it has a retarding influence on stomach digestion. It lessens hunger but does not prolong life during starvation. It is in some measure an antidote to alcohol drinking. **Avoid coffee**—(*a*) in large quantities—drink only two or three mouthfuls and no more; (*b*) with nitrogenous foods (even extra quantity of milk) and (*c*) before retiring.

3. **Coca, Kola**—contain cocaine and other injurious alkaloids. They are drunk as infusion or in wines or taken as snuff or with other foods. Their habitual use leads to permanent damage to brain.

4. **Cocoa** or **Cacao**.—is the kernel of the roasted seed of *theobroma cacao*, plus some starch to dilute the enormous amount of fat (cacao-butter) contained in the kernel, which, if undiluted, would upset the stomach. COMPOSITION of natural Cocoa bean:—Fat 49, nitrogenous substance 14·76, starch 13·31, ash 3·65, theobromin (allied to thein and caffeine) 0·5 to 1·7, tannic acid. Cocoa-*nibs* are the seeds roughly broken; *flake* cocoa is the nib well crushed; *soluble* cocoa is the seed freed from cellulose; *chocolate* is ground cocoa minus some of its fat and mixed with sugar, starch and flavouring objects. ACTION.—Cocoa seed, as it occurs in nature, is a complete food like milk; but the dilution with starch that it undergoes at the hands of the manufacturer, coupled with the very small

quantity that is necessary to prepare a cup of the decoction, rarely imparts any real food value to it; the proportion of theobromin in a cup is infinitesimal.

ANTISCORBUTICS :—Wines, fresh fruit juices, fresh vegetable juices used as beverage are antiscorbutic. Their use is compulsory on boardships during long voyages.

B. CONDIMENTS.

Condiments are substances taken with food to stimulate appetite and promote digestion.

They comprise—(*a*) *salt*, (*b*) *acids* like vinegar, lemon juice, (*c*) *pungents*—like mustard, peppers, ginger, cayenne pepper (*d*) *spices* and (*c*) *sweets*.

Salts.—chemically pure salt is dry and forms fine crystals; impure salt (containing magnesium sulph) is deliquescent and crystallizes in large masses. Of the various kinds of salt in use in India, we find (*a*) *Saindhab*—which is obtained from mines in the Punjab; (*b*) *Soubarcha* or *Sachal*—from briny waters of streams flowing at the foot of the Himalayas; (*c*) *Sambhar* or *Sakambhari*—from the Sambhar lakes in Rajputana; (*d*) *Karkach*—from sea water, by crystallization; (*e*) *black salt*—from briny earth; [*Khanri*—is impure sulphate of soda and *Beet salt* is common salt + myrobalans mixed by aid of heat].

Amount required.—An ordinary mixed diet contains sufficient salts for the body's needs; an additional 2 grammes per diem is quite enough. Vegetarians require more salt than meat eaters. The use of salt along with milk retards digestion. Complete withholding of salt from food is injurious; it is permissible only in cases of anasarca. *Its functions in the economy.*—The chlorides keep in solution the globulins of blood and other fluids, are a source of hydrochloric acid of the gastric juice and help the digestion of albumins. Excess of food is found to be much less injurious when salt is freely taken. Salts augment renal secretion and help osmotic interchange of the various fluids of the body.

Acids.—Acids are used with four objects : (*a*) for their sharp taste and refreshing qualities ; (*b*) for their power of helping digestion, as in the case of vinegar which softens cellulose and muscle fibres ; (*c*) for their antiscorbutic properties, as in the case of lime juice on boardships during long voyages ; (*d*) for their diuretic or laxative or other medicinal properties ; thus, a cold infusion of tamarind is a laxative, lemon juice is diuretic, baked green mango pulp served as sherbet is cooling and so on. The acids are *used in various ways* : They may be eaten in the raw fruit (as unripe mango, tamarind, emblic myrobalan, jujube fruit &c.), or cooked (as in the case of chalta) or as tarts (chutneys) or as pickles or salads &c. Of these we speak only about vinegar in detail.

Vinegar—is crude and weak acetic acid. The amount of glacial acetic acid should be 3 to 6%. It is named according to the source of its origin—(*a*) malt vinegar (made from malt), (*b*) wine vinegar (from white wine), (*c*) wood vinegar (from wood, by destructive distillation). That made from weak wine is the best. Besides acetic acid, vinegar contains alcohol, ethers, sugar, gums, alkaline acetates. **Uses.**—It adds to the relish for food, is an antiscorbutic, maintains alkalinity of blood, and helps digestion, particularly of that of shell-fish. [Taken in excess, it impairs digestion. It dissolves lead, zinc, copper and tin from vessels in which pickles &c. are preserved.]

Pungents & Spices—add to the relish for food and reflexly excite salivary and gastric secretions, expel flatus and thus act as carminatives and aids to digestion.

Sweets—act as valuable food ; they are, therefore, a necessity as well a luxury. **Varieties :** Most of the sugar we eat is *cane* sugar ; its uncrystallisable portion is called *molasses* or *goor* ; Indian molasses is bitterish from overboiling, thin and fermented. When the better qualities of *goor* have been drained off molasses, we get the brown or *country sugar. Rab goor* is a coarser form of goor ; the palm-molasses is called *jaggery. Loaf* sugar is raw uncrystallized sugar refined or worked up. Sugar *candy* or *misri* is twice refined sugar. *Glucose* (grape sugar) crystallizes imperfectly, is two times less sweet than cane sugar and does not possess much food value. *Honey* is a solution of sugar mixed with odours and other peculiar principles, colouring, gummy and waxy materials ; it is one of the most assimilable forms of sugar. Honey from certain bees is poisonous, as Apis florea. **Actions** : Taken on empty stomach, sugar excites irritation ; sugar therefore should be taken at the end of a meal. If taken in excess, it produces fermentation (flatulence), indigestion and catarrhal condition of intestines. This last favours growth of worms. Taken in moderation, it gives *zest to digestion* and *removes fatigue* quickly ; it is, in consequence, taking the place of alcohol among soldiers on the march. It is also considered to be a valuable *brain food* and helps a person to *grow fat.* Sweetmeats are **coloured** with (*a*) vegetable dyes like—saffron, turmeric, anatto, cochineal, logwood, chlorophyll ; (*b*) mineral dyes like—iron, lead, copper, arsenic, chromium, zinc ; and (*c*) aniline dyes. [To detect the nature of the colouring, dissolve a little of the sweetmeat, in distilled water and add to it sodium hypochlorite : if the colour is bleached, it is organic and probably harmless.]

CHAPTER XIII.

(A) FUEL VALUE OF THE FOOD-STUFFS.

We eat to live; we live that we may work. But we often forget that, even in the idlest of us, and in our quietest moments, our heart*, our respiratory muscles, and our secreting glands are continually at work. Whence is the motive power of all this work? It is from food: for, food gives energy.

Energy resides in the nervous tissue; *strength* resides in the muscles. Energy is the inherent power of doing work. On all sides of us, we see one kind of energy being *converted* into another. If a hammer strikes a nail repeatedly, the energy of the falling hammer is changed into sinking (movement) of the nail into the piece of wood and the heating of the nail. Similarly, in an engine, the energy created in converting water into steam is transformed into a force that drives its wheels. In order to be able to *measure* energy, *i. e.*, the work done, what is known as the "foot pound" is taken as unit.

A foot pound represents the quantity of energy that will raise one pound to a height of one foot. The amount of energy obtainable from a given weight of matter is proportional to the heat given out during its combustion—*heat and muscular power being mutually convertible inside the body.* A unit of heat is called a **calorie** and, according to *English* measure, it is put in foot pound or foot ton; and, according to *continental* measure, in **gramme metre** or kilo gramme metre; the calorie thus represents nothing but the amount of energy required to raise the temperature of 1 kilo. (or 1 litre) of water 1°C—or, which is the same thing, 1 lb of water 4° F. **An average adult requires** at least 2500 calories a day for normal existence, 2000 during absolute rest, 3500 during moderate muscular work and so on.

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* This *internal* mechanical work entails an energy equivalent to 260 foot-tons.

It has been experimentally found that one ounce each of dry—

Proteid	yields	173	foot	tons	of	potential energy	,
Fat	„	378	„	„	„	„	,
Carbohydrate	„	135	„	„	„	„	.

The human body, unlike a perfect machine, *cannot* transform *all* the potential energy into mechanical work; **the human body requires** *five* times as much potential energy in food as its output of mechanical work; or, in other words, the human body can convert only $\frac{1}{5}$th of the food into energy. Then again, about 5 to 10% of all the common food-stuffs is indigestible and, therefore, their energy is not available. So also, from meat-rations, 20% of the gross weight must be deducted for bone.

Proteid contains 16% nitrogen and 50% carbon, *i.e.*, in a proteid molecule, the proportion of nitrogen to carbon is as 1 : 3·5. When burnt inside the body, the heat-value of proteids is equal to that of carbohydrates and is therefore, a little less than one-half the value of fat as a heat-producing agent. The proteids, fats and carbohydrates replace one another in almost the exact proportion of their heats of combustion. The **calorific value of any food** is obtained by multiplying the per centage of proteid, fat and carbohydrates by the amount of heat developed by 1 grm. or 1 oz. of each and adding together those products: this gives the heat to be obtained from 100 grms or 100 oz. The nutritive value (and not absorbability) of vegetable proteids is equal to that of animal proteids.

For hard work, more nitrogenous food and proportional excess of carbohydrates must be provided for, though the most valuable source of muscular energy is sugar. It has been experimentally found that, (1) the average weight of a European is 140—150 ℔; that of an Indian is 115 ℔ (male) or 105 ℔ (female); (2) that during "ordinary" work, a European consumes an energy of 300 foot-tons; an Indian male 230 foot-tons and an Indian female 215 foot-tons; and (3) that during laborious work, a European consumes 450 to 500 foot-tons of energy, an Indian male, 345 to to 383 foot-tons and an Indian female 315 to 350 foot-tons of energy. Or, in other words, **a man requires** about $\frac{1}{10}$th ounce of water-free food for each 1 ℔ of his body weight; for ordinary work, about $^{1}/_{7}$th oz; for laborious work, less than ⅙th oz per ℔ of body weight. On this basis, he requires, of proteid 0·17 oz, fat ·007 oz, carbohydrate ·080 oz and salt ·003 oz, or a total of 1·07 oz.

(B). DIET CALCULATIONS.

In calculating diets, remember (*a*) that no single proximate principle can support life; and (*b*) that though the nutritive value and heat-producing power (as ascertained chemically) loom large in all diet calculations, in practical life, we must take into consideration the following influences:—(*a*) **Digestibility** of a diet.—This is specially important in the case of brain workers. The digestibility of a meal is increased by *variety*, by its *palatability* and by the *food accessories*; *cooking* increases the digestibility of starches but renders eggs difficult of digestion. Thorough *mastication** as well as *presentable appearance* and *appetising flavour* of a food ensure proper insalivation and reflexly excite gastric secretion and the hormone 'secretin' from the duodenal mucosa. (*b*) **Absorbability**—*i. e.*, passage of the digested or prepared food through the walls of the intestines into the blood. *Fats* are absorbed only when emulsified; *starches* are easier absorbed than proteids; *animal* fats and animal proteids are more easily absorbed than vegetable ones. It is desirable that some portions of food though digested should remain unabsorbed, just to stimulate intestinal peristalsis. The proteid of meat is more quickly and fully absorbed than that of dals and pulses. (*c*) **Age, Sex** and **Body weight**:—Capability for work is usually proportionate to body weight; women require one-eighth less food than males. A child requires proportionately more *fat* and proteids than an adult and during pregnancy, women take more food with advantage. (*d*) **Climate** and **Season**: In hot climates and weathers, fats and proteids are taken less, while in cold climates fats are more wanted. (*e*) **Personal idiosyncracy**—of certain individuals against or in favour of certain articles of diet.

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* **Proper mastication** has these advantages: (1) Food is thoroughly insalivated and therefore becomes digestible; (2) it lessens craving for more food or rich food—the appetite becoming discriminating, flesh-food being less called for, thirst becoming less and a simple dietary being preferred. Hence, (3) there is economy of nutrition, diminution of intestinal fermentation and in size of stools. Chew a food so as to enjoy every taste of it and swallow it only when it practically swallows itself.

In calculating diets for individuals, we must remember **two essential facts:** (*a*) that the allowance of food shall be neither too much nor too little for the individual's age, sex, body weight and labour; and (*b*) that the alimentary principles must be in proper proportion—*i.e.*, if, say, an excess of carbon is given to stimulate muscular activity or heat-production, the amount of nitrogen necessary to repair tissue wasted thereby must be simultaneously provided for.

Diet calculations are *emperical*, when they are based on analyses of diets of healthy persons living under known conditions (actual dietary); they are *physiological*, when based on intake and output of the chemical constituents of food, as well as on the amount of potential energy expended (standard dietary).

Diet calculations are of **three kinds:** (*a*) those set in terms of Nitrogen and Carbon; (*b*) Those set in terms of proteids, carbohydrates and fats. And (*c*) Those showing the actual quantities of individual food-stuffs necessary.

An average adult man requires 80 to 100 oz. of FLUID a day—the quantity depending on the amount of exertion undergone and the temperature and humidity of air. If 20 oz. of this is taken in the solid food, 60 to 80 oz. of pure water must be supplied. But, all calculations of food are usually on the basis of water-free diet. As most of the solid diets contain more than 50 to 60 % water, in actual calculations, we have to more than double the quantities].

I. To find out **how much carbon and nitrogen** a person requires, calculate his waste-products by lungs, kidneys, bowels, skin etc. On an average, they amount to 300 grs nitrogen and 4800 grs carbon daily ; so, this is the quantity we must supply in his daily food—N : C :: 1 : 16 or, Nitrogen 6% and Carbon 94%, or, Nitrogen 20 grammes and Carbon 320 grammes.

[The formulæ of the proximate principles (proteids, fats and carbohydrates) show the presence chiefly of carbon, hydrogen and nitrogen. Of these, the *hydrogen* mixes with the oxygen and forms water, being completely burnt out. But as *nitrogen* and *carbon* remain, these, therefore, are the only two substances of which we take any account in calculating diets. Hence, in calculating diets, we take advantage of what is called *the starch equivalent of fat.*]

II. To find out the amount of carbohydrate, proteid and fat. Experience has shown these things to be correct : (1) That the proportion of albumin to starch (called *Nutrient Ratio*), including with the starches, the starch-equivalent of fat, must be as 1 : 6 or 1 : 5. The meaning of this is, that *the nitrogenous food must constitute nearly one-fifth of the non-nitrogenous food.* Any ratio below 1 : 5 (as in the case of rice, in which the nutrient ratio is 1 : 10 of albumin) is detrimental to health. ["*Nutritive Value*" means the sum-total of the albumin, fat and starch or the starch-equivalent of fat]. The proteid may be obtained entirely from vegetables or meat, as desired. (2) That one part of oil or fat is equivalent to 2·3 parts of starch ; hence, 2·3 is the starch-equivalent of 1 part of oil ; thus, the non-nitrogenous constituents may be either wholly fat or wholly carbohydrate or a mixture of the two. This enables us to lay down the average per centage as—

	Per cent. =	Grammes. =	Ounces (dry).
Proteids	21	120	4½
Fats	12	85	3
Carbohydrates ...	63	400	15¼

III. Given certain articles of food, **to find out the actual quantities** of each required, we must know (*a*) the condition (as to rest or work) under which diet has to be calculated and (*b*) the composition of each article of diet. Let us suppose that we must find out the quantity of bread, butter and beef required for an average man doing moderate work. The composition of bread, butter and beef is :—

	Proteid	Carbo-hydrate	Fat
Beef	20·5	...	8·5
Bread	8·0	50·0	0·5
Butter	1·5	1·0	83·5

And we know (See p. 187) that an average man doing moderate work requires of—proteid 120 grammes, carbohydrates 400 grms. and fat 85 grammes.

Now, if x=amount in grms. of beef required,
y ,, ,, bread ,,
z ,, ,, butter ,,

Then,

$$\tfrac{20}{100}x + \tfrac{8}{100}y + \tfrac{1}{100}z = 120 \text{ (Beef)}$$

$$\tfrac{50}{100}y + \tfrac{1}{100}z = 400 \text{ (Bread)}$$

$$\tfrac{1}{100}x + \tfrac{1}{100}y + \tfrac{83}{100}z = 85 \text{ (Butter)}$$

From these equations we get—
$x=278$ grms. $=9·8$ oz. beef
$y=798$,, $=28·2$,, bread
$z=89$,, $=3$,, butter

(C) AMOUNT OF NITROGEN NECESSARY.

Opinion is divided as to the minimum quantity of nitrogenous food that is compatible with health. Liebig first gave to proteids the most important place, but he was quickly supplanted by Moleschott, Voit and others, whose opinions still find favour. Of late, Chittenden has raised his voice against the amount of proteid now used and the whole question is yet unsettled. We simply give the views of the important workers.

I. **Liebig** held that all muscular energy hinged upon oxidation of proteid materials assimilated. This view laid stress on proteids as the chief food ; *it is wrong* ; because, muscular work does not entail corresponding nitrogenous waste (as found from urine examination)—the total nitrogen in the urine being a true measure of the proteid of the katabolism as well as of the assimilable form of proteid available in the diet.

II. **Later Views.** It was next held that the assimilated proteid breaks up into a nitrogenous moiety which is rapidly excreted as urea and into a carbo-hydrate moiety, the oxidation of which supplies the energy of muscles. This view still holds favour. It is held by **Attwater** of America that *about 20 grammes of Nitrogen are required in 24 hours.* [As proteid = 16% nitrogen, this means *the daily intake of about 125 grammes of proteid.* Now, 1 oz = 30 grammes; therefore, about 4 oz. of proteid are required in 24 hours. In the case of a proteid food, averaging 25% proteid, it would mean the daily consumption of 16 oz of such food] And the same authority believes that *about 320 grammes (11 oz) of carbon in proteid or in carbohydrates and fats are needed daily in the food.* [As the proteid = ½ carbon, 62 of these 320 grammes are supplied in the proteid intake of food, leaving 260 grammes of carbon to be supplied by carbohydrates and fat, and this, according to the ordinary standard, is furnished in the proper proportions, if *50 grammes a day of fat* be eaten and *500 grammes of carbohydrate food.*] Such a daily diet furnishes 3500 or, more correctly, 3025 *calories of fuel material for heat and energy in 24 hours.*

Till now, this view of **Voit, Moleschott** etc. has held sway and on this basis, have been calculated these diet scales :—

	Subsistence (S)	Medium work (M)	Severe work (M)	Laborious work (S)	Sandow's
Proteid (oz)	2·32	4·59	4·94	6·50	13
Fat ,,	0·84	2·96	3·17	2·85	3
Carbohyd ,,	11·5	12·26	15·31	20·10	13
Salts ,,	0·5	1·06	1·13	1·40	...

[M = Molechott S = Smith & Playfair].

As applied to *Indian* males, the figures are :—

	Proteid.	Fats.	Starches.	Starch Equiv.	Nutrient Ratio.
Subsistence ...	2·123	0·752	7·520	9·250	1:4·34
Moderate work ...	2·954	1·412	12·531	15·779	1:5·34
Active work ...	5·41	2·41	27·92	...	...
Hard ,, ...	3·635	2·506	18·190	26·950	1:466

III. Chittenden—thinks that too much of proteid is being taken and that *comparative* proteid starvation is necessary ; he does not trouble about the fantastic changes that proteids undergo inside the body, but he holds that health and vigour can be maintained, without loss of body-weight, on a diet consisting of only $\frac{1}{2}$ to $\frac{1}{3}$ of the proteid mentioned in the "standard" dietary scale of Voit &c., *provided* that once the nitrogenous equilibrium has been established in the body. This means that there should be less meat than hitherto. Chittenden allows 56, 63, and 67 grammes of proteid in 24 hours to his classes A, B and C, where Voit allows 118 grm.

IV. Folin—believes that in the body two forms of proteid metabolism take place ; the one (exogenous) connected with the *ingested* proteid, part of which is excreted as urea and part is used up as energy ; the other (endogenous) is that connected with the daily breaking down of proteid *tissue*, commensurate with the weight of the true tissue elements of the body. The truth probably is this : so long as the supply of *non*-nitrogenous food is adequate, muscular energy is supplied *chiefly* by the *non*-nitrogenous foods, though, perhaps, generally, by *all* the three classes of organic food-stuffs ; when however the capital of accumulated non-nitrogenous food stuffs is exhausted, it is the proteids that supply the energy. On this view, now generally accepted, the non-nitrogenous elements of food are mainly concerned in the changes associated with muscular activity.

V. Mc Cay, examining the diet of the Bengalis, believes to have proved (*a*) that the Bengalis normally live on the *minimum* of proteid advocated by Chittenden or even less ; and (*b*) that nearly even ¼ of the vegetable proteid they take as dal is excreted unchanged by the bowels. To these causes (chronic proteid starvation) he attributes the poorly musculature and still poorer development of the Bengali. His conclusion is that the absence of animal proteids in sufficient quantity is responsible for physical deterioration of the Bengalis ; for, he holds that the *grouping of the atoms in proteid molecule* is different when the proteid comes from the animal or from the vegetable kingdom—and on this depends its absorbability rather than on the absorptive powers of the intestinal canal. There is a great divergence of opinion as to mutual interchangibility of vegetable and animal proteids as regards their nutritive value ; while vegetable and animal fats are so interchangeable.

D. DIET IN INDIA.

When the Aryans first settled in India, they used to take meat and a kind of fermented liquor called 'Soma Ras.' But prolonged stay in this warm and very fertile country and the peaceful pursuit of knowledge made them more or less vegetarians, specially so the more they migrated eastwards. India thus to-day is chiefly a vegetarian country.

The chief **items** of a truly Indian diet to-day are :—*Proteids* : Dal (pulses), beans, milk, curdled boiled milk, atta ; fish and flesh (used only in some parts of India). *Fats* :—Ghee, butter, cocoanut oil, mustard oil. *Carbohydrates* :—Rice, potato, green vegetables, fruits, sugar, some acid etc.

The following comparative table furnishes a rough idea of the average quantity of food, in ounces, used in Bengal :—

	Cooly	Villager.	M. N. hospital.	Med. Col. Hospital.	MC. H. Europ.	Europ. soldier.	Bengal Jail	European Prisoner.	Behar Jail.
Dal ...	6	4	2	18	—	—	6⅙	6⅙	3¼
Fish ...	2⅔	1	1	2	—	—	—	—	—
Meat ...	—	—	—	—	9	16	—	—	10
Atta ...	—	—	—	—	—	13	—	10	—
Loaf ...	—	—	2	—	16	16	—	—	16
Milk ...	—	—	4	10	—	—	—	—	1
Butter ...	—	—	—	—	1	—	—	—	¾
Ghee ...	—	—	¼	—	—	—	—	—	—
Oil ...	—	½	½	—	—	—	·64	·64	½
Rice ...	20	32	20	30	5	—	26⅔	12	6
Vegetables	—	4	2	4	7	16	6⅙	6⅙	11
Sugar ...	—	var.	—	¾	var.	2½	—	—	¾

The following table shows us in juxtaposition the gross amount of the several proximate principles in grammes used by the Bengali and Eurasian Students of certain college boardings in Bengal :—

	Bengali.		Eurasian.	
	No. 1.	No. 2.	No. 1.	No. 2.
Proteids	67·11	43·61	87·56	94·97
Carbohydrates ...	548·73	200·31	376·53	467·00
Fats	71·55	33·92	54·75	56·20

If we analyse these Indian dietaries and compare them with the European dietary the following points come out :—

Indian Diet	*European Diet.*
Volume—is bulky ; ∴, food is liable to fermentation and ∴ to produce indigestion.	Less bulky, ∴, more easily digested and leaves less undigested residue.
Proteid—Poverty, ∴ increased sp. gr , coagulability & salinity of blood ; comparative anæmia ; deficient musculature and growth.	Richness, ∴, florid, robust, muscular growth of body.
Fats—are equally well distributed	in both the dietaries.
Carbohydrate—Richness. Hence dilated stomach, diabetes, amylaceous dyspepsia, flatulence.	Comparative poverty—without much inconvenience.

The inferences, therefore, to be drawn are (*a*) that for an *Indian*, it is better to eschew excess in rice and vegetables and to substitute for them in part by wheat atta, peas, beans, or chhana ; he may in the alternative, take liberally of fish or meat or eggs ; and (*b*) that for an *European* living in the tropics, it is better to take a little more of fish and less of meat, at least in warm weather.

(E) INFANT FEEDING.

In proportion to their body weight, children require more nutriments. Infants at breast take 2½ times as much proteid and five times as much fat and carbohydrates per pound of body weight as adults. Infants fed with breast-milk require less milk than those fed on cow's milk, owing to the complete digestibility of the former. A child between 8th and 14th years of age requires : Meat—6 oz., Bread 14 oz., Potatoes 6 oz., Milk 9 oz., small quantities of butter and fresh vegetables.]

Scheme of Artificial Feeding of Infants.

Age of child.	Ingredient of each Feed.				Total of Quantity of.		Times of feeding.		Frequency in day time.	Normal weight for the age.
	Cow's Milk.	Water.	Cream.	Milk Sugar.	Each Feed.	Food in 24 hours.	4 A.M. to 10 P.M.	10 A.M. to 4 P.M.		
1st Week ...	2 dr.	9 dr.	1 dr.	¼ dr.	1-1½ oz.	10 oz.	10	2	E 2 hrs.	—
2nd & 3rd Weeks	2 "	10 "	1 "	1 "	1½-2 "	12-14 "	10	2	"	—
4th & 5th Weeks	6 "	12 "	1 "	1 "	2½ "	12-14 "	10	2	"	8 ℔
6th Week ...	8 "	16 "	1¼ "	1 "	3 "	18-24 "	7	1	"	—
2nd Month ...	12 "	16 "	1½ "	1 "	4 "	18-24 "	6	1	E 2½ hrs.	9 to 14 oz.
3rd " ...	16 "	16 "	2 "	1 "	4 "	24-36 "	6	1	"	11 to 19 "
4th " ...	20 "	16 "	2½ "	1 "	4¼ "	24-36 "	6	1	E 3 hrs.	13 to 13 "
5th " ...	24 "	17 "	3 "	1 "	4½ "	24-36 "	6	1	"	14 to 18 "
6th " ...	28 "	18 "	4 "	1 "	5½ "	24-36 "	6	1	"	15 to 12 "
6th to 8th Months	32 "	20 "	4 "	1½ "	6-7 "	36-42 "	6	1	"	15¾ to 18¼
8th to 12th "	48 "	16 "	4 "	2 "	7-8 "	35-40 "	5	—	"	18¼ to 22

Note : (1) The above table gives some idea only of the requirements and is by no means absolutely correct. (2) On the day of its birth, the child should be put to breast ; on the 2nd and 3rd days, it should be put every 4 hours. (3) From 6 to 8th month onwards, milk should be supplemented by other solid foods (minced meat, bread crumbs, &c.) and in that case, the frequency of milk feeding should be less. (4) Each breast should be given alternately and for at least 15 minutes (*i. e.*, very slowly). (5) After 8th month, a child should be weaned.

CHAPTER XIV.

(A) COOKING.

Its objects are (1) to preserve the food from *putrefactive* changes ; (2) to increase its *digestibility*, by disintegrating the connective tissues and exposing the component fibres to the solvent action of the digestive juices ; (3) to render it more *palatable* ; (4) to destroy *parasites* ; (5) to produce certain *chemical changes—e.g.*, to convert starch into dextrin, tendons into gelatin, to develop flavour (by setting free the extractives).

General Principles of Cooking : (1) Albumin is coagulated by heat ; hence, if it is intended *to preserve in tact the juices*, it is necessary either to roast the food or to plunge it for a short period into boiling water. (2) If however, *the gravy is the object*, rather than the integrity of the food-stuff itself, the food should be well minced, thrown into cold water and kept as much as possible far from boiling point. (3) Where *softening or disintegration* is the end in view, as in boiling rice, the food-stuff should be either steamed or heated over a slow fire. A thermometer is evidently a great adjunct to the kitchen. The Hindus in ages gone by used dung cakes and specified faggots for their different heat-giving range. Now-a-days, wood, coal, coke, coal gas and electricity are used in cooking ; of these, the last two are more easily controlled and very cleanly. (4) *Milk* is best drunk fresh and unboiled ; but one is exposed to so much bacterial infection that it is always safe to take milk and the liquid preparations of milk, fresh and boiled. (5) *Fruits*, seeds, tubers and roots are best taken steamed in their skins. (6) *Egg* : The harder it is boiled the more difficult it becomes for digestion.

Varieties of Cooking : (1) *Broth or Bouillon.*—Shreds of meat are first put into cold water and then gradually heated—but never boiled. (2) *Meat Extracts.*—They contain only the flesh-bases or extractive and mineral matters. Hence, they are only stimulants and appetisers. [To give them some food-value, peptones, gelatin, fat and vegetables are added]. Mode of preparation: Slightly acidulated minced meat is heated to a little below 75°C. Raw Meat Juice—is prepared as above, without heating but by squeezing the meat. Hence, it contains soluble proteids of meat, blood, extractives and salts. (3) *Jugged Soup*: Meat is put into a closed jar which in its turn is kept inside a closed jug half full of water. When this is set over fire, steam and pressure extract the juices of the meat. *Meat Essences*=more liquid meat extract. *Soup*—is gelatin plus any other substance desired. Cartilage, bone, connective tissues &c. or pure gelatin is utilized for this purpose. *Roasting*.—A lump of meat is suddenly plunged into boiling water for 5 minutes. It is then cooked very slowly. *Broiling* and *grilling* are identical processes applied to smaller portions of meat. In these processes, the greatest amount of juice remains in the meat, only a part going to the gravy. *Stewing*—is cooking a meat at a slight heat so as to impart a great deal of its juices to the gravy.

(B) INVALID & SICK DIETARY.

In dieting the sick and the invalid, remember four facts: (1) That during illness, the body *loses its albumins* more than its fats; (*b*) that there is, in some cases, a tendency to *accumulation in the body* of the products resulting from the destruction of the tissues; (3) that during fever, the *potassium salts* are eliminated in excess and (4) that in ill health, the *gastric digestion* may be more or less in abeyance. Bearing these in mind, we must prescribe (1) every diet in *liquid* form; milk is liquid outside the body—but is solid inside it; hence, avoid milk except it is well diluted or made into whey. (2) Do not give *albumins*—rather give albuminoids (jelly, broth, meat extracts &c) (3) Give *farinaceous* food. (4) Give cold *water*, tea, coffee, lemonade, ad lib. (5) Give *alcohol* only when there is extreme nervous prostration and food is not well taken.

(C) DIGESTION OF FOOD.

"Digestion," includes at least three main steps—

(*a*) **Digestion proper**—*i. e.*, conversion of the food materials into diffusible *liquids* such that they may be readily absorbed. For example—fat is 'digested' only when it is emulsified, starch when converted into maltose and proteids when converted into amino-acids. But everything that is digested is not absorbed.

(*b*) **Absorption**—that is to say, the passage of the digested or liquefied food *viâ* lacteals or liver, into the blood stream. (*i*) *Fat*, emulsified, is taken up by the villi into the lacteals and, in the form of chyle, is poured into the right side of heart by the thoracic duct. (ii) *Starch*—converted into maltose, is taken up by the portal blood into the liver, where some of it is stored up as glycogen, the rest reaching the right side of the heart. (iii) *Proteids*—are also absorbed as amino-acids and thrown into the right side of the heart by way of the portal circulation. Thus, the absorption of digested food in the—*Mouth* (dextrin) is insignificant ; in *Oesophagus*—is nil ; in *Stomach*—(peptones, albumoses) a good deal ; in *Small Intestines*—a very large amount of fat (emulsified), maltose and amino acids ; and in *Large Intestines*—the greatest in amount.

(*c*) **Assimilation** = Nutrition—*i. e.*, making the absorbed food a part of the body. Thus, proteids stir up metabolism and activity, carbohydrates lay on fat, fats give heat, salts direct metabolism and so on.

The following table shows at a glance the process of digestion in man :—

Stages.	Agents.	Their action.
Inside Mouth.	Teeth* ...	... Cut, tear and crush into pulp all solids.
	Tongue	... By relishing food, reflexly increases salivary secretion ; helps bolus down the throat.
	Saliva (Ptyalin)	... *Starch* and farina in part converted into soluble dextrose.

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* On the integrity of this first action depend those of the rest.

Stomach.	Gastric Juice* ... 1. Pepsin & HCl ...	1. Proteid and gelatinous coating of *fat* globules dissolved. 2. *Proteids* are converted into soluble peptones and albumoses.
	2. Rennin ...	3. Curdles *milk.*
Small Intestines.	1. Bile† ...	1. Helps action of Pancreatic juice on *starch* and *proteid.* 2. Dissolves and emulsifies *fat.*
	2. Pancreatic juice= (*a*) Amylopsin (*b*) Trypsin (*c*) Steapsin. (*d*) Milk curdling ferment	Converts *starch* into maltose. Converts *proteids* into peptones (*a*) Emulsifies *fat.* (*b*) Splits up fat into glycerin and fatty acids ; fatty acids ; the unite with the alkalies in the pancreatic juice and form soaps curdles *milk.*
	3. Succus entericus (Erepsin).‡	1. *Starch* is converted into sugar ; sugar into lactic acid, that into butyric acid, that again into H, CO_2 &c. 2. *Proteids* are converted into amino acids. 3. *Fats*—are split up and emulsified. 4. *Milk* is curdled.
Large Intestines	Bacteria ...	Complete the digestion process especially that of *cellulose.*

(D) HOURS OF EATING.

Food should be taken at regular hours and at proper intervals and as a rule, two principal meals are to be taken daily. Old men require less, and children require more, frequent eating. A full-meal takes from 4 to 6 hours to be digested and at the end of each digestion, the stomach should have some time for rest. All hours of meals should be adjusted so as to satisfy these conditions : (1) No one should go to bed on a full stomach. (2) No meal should precede or follow violent mental or physical exertion. (3) No kind of work (mental or physical) is to be undertaken on an absolutely empty stomach.

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* The digested mass that leaves stomach is called *chyme.*

† *Bile secretion* is—(*a*) dependent on amount of acidity of chyme ; and (*b*) helps to develop the activity of ferments of pancreatic juice.

‡ The degree of acidity of contents of stomach is responsible for (*a*) opening up intermittently of the pyloric orifice and (*b*) amount of bile secreted.

(E) DISEASES ARISING IN CONNEXION WITH FOOD.

They are divisible into four groups as follows :—

I. Acute poisoning from eating foodstuffs—(1) That *normally* contain poisonous *products* ; (2) That are *wholesome, but disagree* with the host, on account of age, illness, idiosyncracy, mode of eating or want of exercise ; (3) That *contain poison*, owing to (*a*) the animal having fed on plants or grains poisonous to man ; or (*b*) to accidental metallic contamination ; (4) That have in them the *germs of specific disease*, or of pathogenic *bacteria* or products of *decomposition* or gross *parasitic worms*.

II. Auto-intoxication—by ptomaines developing inside alimentary system.

III. Deficiency Diseases : Beri beri, epidemic dropsy, scurvy (adult and infantile), pellagra, &c. (See Author's Jurisprudence). These are due to want of a principle called *vitamine* from the food-stuff. There is a separate beri-beri vitamine, a scurvy-vitamine and so on. The beri-beri vitamine is necessary for the metabolism of nervous tissue—vitamines being activators or hormones. In beri beri, the vitamine can be supplied by feeding the patient on yeast, moong dal or acidulated extract of rice polishings ; in scurvy, the vitamine is supplied by fresh fruit juices. Note that vitamines have nothing to do with that power of foods which increases weight.

IV. Plethora—Those who habitually eat and drink to excess suffer from *gout*, *obesity*, *dyspepsia* &c.

(F) DISEASES DUE TO FOOD.

Procedure:—In cases of suspected food-poisoning, enter on a piece of paper (*a*) every *article of food* that has been consumed, (*b*) details as to the *water*, the *condiments* and *utensils* used, (*c*) the *persons* employed at each stage of cooking and serving ; and (*d*) the place where and the manner in which, food was kept. Then find out the edibles *eaten in common* by the affected persons ; and finally, by a process of exclusion find out the offending dishes. Verify your finding by *microscopic* and *bacteriological* examinations.

Milk can give rise to—(1) TUBERCULOSIS.—The danger of using milk of *one* cow is great, mixed milk being safer. If milk is centrifugalized, it remains infectious, though most bacteria are thrown into the cream. It is not safe to drink the milk of tuberculous cows ; and when there is tuberculosis of udders, even though bacilli be not demonstrable in the same, the milk is positively dangerous. A painless hard lump in the udder slowly enlarging is tubercular. (2) FOOT AND MOUTH DISEASE —affects man if infected milk is drunk without boiling it. (3) TYPHOID FEVER, *Malta fever* (which is transmitted by milk of goats), *Cholera*, *Diphtheria*, *Scarlatina*, *Tyro-toxicon* poisoning (from bad cheese, dadhi or milk) ; *Diarrhoea* and *gastritis* ; *Metallic* poisoning from using tinned milk ; *Alkaloidal poisoning* from the cow having grazed on belladonna or rhus toxicodendron leaves etc ; *Scurvy*, *Rickets*, from habitually feeding on tinned milk. [Virus of rabies is not communicable through milk ; boiling destroys the germs of foot and mouth disease but not the spores of tubercle bacilli].

Meat can transmit to man—anthrax, tuberculosis, foot and mouth disease, rabies, glanders and farcy, worms.

Fish.—Some give rise to (*a*) TAPEWORM, encysted form, (*b*) symptoms of poisoning if eaten during the SPAWNING season.

Molluscs & Crustaceans produce—mytilotoxœmia, nettle-rash, typhoid fever, diarrhœa, dyspepsia.

Grains—if badly prepared or cooked give rise to—diarrhœa, dyspepsia, flatulence and indigestion. *Rye* produces ergotism, *Maizes*—pellagra (elephantiasis Italica), *Rice*—Beri-Beri, *Darnel*—kodra, *Lathyrus*—lathyrism, *Potato*—solanin poisoning.

Green vegetables produce—Tœniœ, diarrhoea, indigestion.

(G) CONTROL OF MILK SUPPLY.

The co-operation of three agencies is necessary to the successful control of milk supply, viz., Veterinary officer, Health Officer and the local police and magistracy.

Veterinary Officer's Duties. (1). TUBERCULIN should be injected, at intervals of six months, three times, on all cows of a herd, to find out by the febrile reactions, those affected with tuberculosis. Those that do not react, (healthy ones), are allowed to supply milk ; those that do react are branded and sent out to some distant open shed and are at once dried off and fattened for the butcher, unless already in calf. These calves are sent to the healthy shed. The old sheds are disinfected and all new purchases are kept in quarantine. Attendants on healthy and diseased cows are never allowed to mix with each other. The best breed of cows, which are the largest milkers, are on that account, the most susceptible to phthisis. Even when the disease is well advanced in them, they continue yielding the same amount of milk but of decidedly poorer quality. The animal suffers very little in external appearances even when the disease is well advanced. (2). EXAMINATION OF UDDERS and of general health of the cows should be made at least twice a year. All udder diseases should be made notifiable. (3). Regular examination of the FOOD and WATER SUPPLY must be made. (4). Daily GROOMING of cows should be insisted on as well as their AIRING in plenty of sunshine. (5). Cows should be KEPT CLEAN ; TAIL and HAIRS on right side of the cows, should be kept clipped short and all alvine discharges, which harbour virulent tubercle bacilli, should be [illegible]ed.

Byres (cowsheds) : *Site*—in a spacious, cool, airy place, sheltered from midday and afternoon sun and well lighted. *Floor*—made of hard pavior bricks or rough concrete, slanting (1 : 30) to a well laid gutter. The actual space for cows to stand on should be so short that all manure may drop into the gutter and not on the floor. *Drain*—is to be of glazed half pipes or cement 6″ to 8″ deep with sufficient fall, leading to an untrapped masonry tank—never into a pond or ditch. *Floor space*—600 to 1000 cft. for each cow, exclusive of gangways. A 3ft space should intervene between the feeding troughs and wall. *Ventilation*—should be by openings in the front wall and louvred apertures in the opposite walls, well over the heads of the animal and in the roof, over which no loft should be. *Water supply*—should be sufficient to flush the floors daily. Filtered water should be supplied from cisterns to individual troughs, mounted 3 or 4 ft from the ground. They should be frequently cleaned. *Cleanliness*: (1) Eating troughs should be kept clean and dry when not used. (2) Dung heaps or dung pits should not be allowed near. (3) Hay should not be stored in the stable in the space over the cows, unless the ceiling is made tight—or else dust, chaff, cobwebs may fall on milk. (4) Stable should be whitewashed at least twice a year (5) Ceilings should not harbour dust or dirt.

Milkers. Only healthy men of cleanly habit, wearing clean clothes should milk. They must wash their hands with soap and water and dry them on scrupulously clean towels before milking.

Milking : (1) *The floor* should be swept at least one hour before milking so that all dust may settle beforehand. (2) The *cows should be washed* specially upon the flanks, sides, udders and belly sometime before milking. (3) Between cleaning and milking, *lying down* is to be prevented by fastening a throat latch of rope across the stanchions and under the neck. (4) *Fodder* should not be given the cow while milking, lest dust therefrom fall into the milk. (5) *Teats* and *milking fingers* must be kept dry throughout. (6) *Reject*—the first few streams of milk from each teat, the milk from cows 30 days before and 10 days after calving and the milk of diseased cows.

Utensils—(including strainer) must be cleaned only with clean water and finally rinsed out with boiling water before and after each using. After use, they must be well cleaned and kept dry, in a clean place.

Storage. Only sterile utensils should be used, the milk being cooled as soon as drawn. Vessels should be closed air tight and milk distributed only through taps attached to these vessels.

Transit.—Milk can be conveyed from place to place only in sealed dust proof cans. Throwing a handful of straw or twigs into open cans should be penalized.

Marts. They should be *situated* in places where no dust and no effluvium of any kind exists—hence, away from vegetable or fish or meat markets, away from urinals, stables, byres, privies, dusty streets, sewers, drains etc. The *floor* should be of impervious material, well sloped and kept dry. The place should *not be used* for living or other purposes. Flies, dust, effluvia, persons suffering from any infectious or dangerous diseases should be rigorously *excluded.* It should be washed thoroughly clean daily and lime-washed at least twice a year. All *utensils* and *paraphernalia* should be cleaned and kept dry. On no account is a hand or a small distributing vessel to be dipped into milk. Promiscuous *mixing of milk* from different farmers should be forbidden. Whatever applies to milk applies, also to dadhi, kshir, rabri and other liquid preparations of milk.

Preservation.—As boiled milk is spoiled milk, and as milk can harbour several germs, of which the tubercle bacillus is the most resistant of heat, the following are the methods used to keep milk fresh :—(1) PASTEURISATION : this is heating the milk short of boiling. It is of two kinds : *Flash Pasteurization*—in which milk is raised to 77°C for a minute ; and *Retainer Pasteurization*—in which milk is raised to 65°C for 25 minutes. The latter is the safer method. (2) STERILIZATION at a temperature higher than 100°C, in sealed chambers, under pressure. But slowly raising its temperature to 97°C practically sterilizes milk. (3) CONDENSATION in vacuo (to prevent frothing) at temperatures over 100°C. The lower percentage of water and the higher percentage of sugar is inimical to bacterial growth. DESSICATED POWDERED milk is to some extent resistant to growth of germs (4) REFRIGERATION at temperatures between 0°C to 10°C. (5) Addition of CHEMICALS.—See Author's Jurisprudence and p. 209.

GHEE AND BUTTER.

STORAGE. Butter and *prepared* ghee may be stored in one room, in covered metallic receptacles ; such a room should have impervious floor, be airy and well ventilated, be used only for such storage and no other purpose, should be at least 20 feet away from latrines or water-closets and thoroughly disconnected with any drain.

MANUFACTURE : The melting room should be separate, have properly constructed fire-place and flue and all fuels should be stacked compactly in a separate place. Pans, ladles etc. must be kept clean and on clean tables or shelves—never on floor.

CHAPTER XVI.

(A) FOOD ADULTERATION.

Adulteration is effected by **1. Adding to** food, substances that are—(*a*) *inferior* in quality but cheaper ; (*b*) bulky or possess *weight* but are inert ; or, (*c*) *colouring* or *flavouring* or *sweetening* in property—in order to hide the inferiority or fraudulent substitution of the stuff. **2. Taking away** from it, some *valuable* ingredients of it.

The following is an enumeration of the principal articles adulterated, showing against each the various adulterants used.

Arrowroot—Starches of potato, rice, maize. [If arrowroot is pure, it will *crackle* when rubbed between the finger and thumb and when made into a jelly, will retain its *firm* consistency.]

Atta--Soap-stone, chalk, lime, alum, barium carb. or sulphate, zinc sulph., kaolin, flours of rice, barley, potato, beans, peas, maize, oats, rye, etc.

Barley—[Bleaching with sulphurous acid gas adds to its weight and appearance] French chalk, chhatoo, wheat flour, potato starch.

Beer—water, cereal starches, 'saccharin', glucose, salicylic acid, quassia, gentian, salt, alum, sulphates of lime and iron, picrotoxin. [*Contamination* : Arsenic].

Brandy—water, silent spirit [Not from grape juice at all !]

Bread (See Atta).—Flour of potato, rice, pea, or bean ; chalk, gypsum, alum.

Butter—palm oil, beef fat, cocoanut oil, vaseline, margarine, tallow, lard, plantain meal, anatto, water upto 75°/₀ [*Artificial butter* =pea nut, cotton seed, cocoanut, sesame, and oleo oils, neutral lards, coloured and worked up.]

Canned fruits—'Saccharin' for sweetening, sulphate of copper for greening, aniline dyes for colouring. [*Contamination* : Lead, zinc, copper, tin etc.]

Cayenne pepper (in powder)—Brick dust, red wood dust, red ochre, red lead, iron.

Chha'na'—old chhana, water (whey).

Chocolate—ground cocoa shells, potatoes, arrowroot, barley, farina, gum, mutton or veal suet.

Cocoa—starch of sago, arrowroot, or potato, powdered shell of the cocoa bean, sugar.

Coffee—chicory, dandelion roots, acorns, date stones, bread, beans, exhausted coffee grains, malt, rye, burnt sugar.

Flour—See Atta.

Fruit syrups—Imitation fruit juices and syrups ; salicylic, benzoic acids.

Gelatine—bleaching agents ; may be prepared from unedible portions of animals.

Ghee (Its *melting point* is 96° to 96°.8). Lard, mohua oil, raw castor oil, animal fats specially mutton fat, vaseline (white), groundnut oil, meals of rice, bajra, millet, potato, sweet potato, kachu, yams, ripe plantain. Impure and adulterated ghee is often *remade* with milk or curd to render detection difficult.

Goor (Molasses)—sugar.

Honey—cane sugar, glucose, invert sugar, gelatine.

Jams—artificial colour and flavours, glucose, coal-tar dyes, marrow, carrots, turnips.

Lard—fat from cotton seed, beef ; water.

Meat Extracts—Glycerine, boric acid, sulphate of soda, extracts of yeast.

Milk. Its sp. gr. is normally 1030—1032. If fat is removed, its sp. gr. increases. To lower the sp. gr. of skimmed milk, add water or chalk, arrowroot or other starches, buffalo's milk, gum, milk of lime, oil of almonds, molasses cake (batasa.)

Mustard (*powder*)—turmeric, cayenne pepper, ginger, radish and rape seed, potato starch, pea flour, linseed meal, yellow ochre, plaster of Paris, clay. [Mustard oil is abstracted.]

Oatmeal—barley meal, ground husks of other cereals, maize.

Oils :

(1) *Almond*—oils of cotton seed, walnut, poppy seed, sesame, pea nut, apricot, peach kernel.
(2) *Castor*—Resin, cotton seed, linseed and colza oils.
(3) *Cod liver*—Seal, whale or blubber oils.
(4) *Mustard*—oils of 'sorgonja', ground nut oil, poppy oil, til oil, juices of radish, bloomless or other mineral oils, cayenne pepper.
(5) *Olive*—cotton seed or castor oil, lard etc.

Rice—polished with French chalk, mixed with broken, mouldy, old rice, and abounding in insects.

Rum—made from beet sugar, molasses, silent spirit, water etc.

Saffron—flowers of similar kind. **Sago**—potato starch.

Salt—corn starch, chloride and sulphate of magnesium, lime salts, sodium nitrate. **Sherry**—Raisin wine, oil of almonds.

Sugar—soojie, fine white sand.

Tapioca—gum, potato and other starches.

Tea—willow, beach or elder leaves; exhausted or old leaves, clay, lime or ferruginous sand.

Vinegar.—Sulphuric acid (over 1 : 1000 [*Artificial Vinegar*= acetic acid dil + caramel.] **Wheat flour**—See Atta.

Wines—Mixture of figs juice, raisins, glucoses, pot. bitart., coal-tar dyes, alum etc. *Contaminations* : Sulphate of lime, lead, copper, arsenic.

(B) FOOD INSPECTION.

MEAT EXAMINATION.

Examination of the Animal before slaughter. Signs of a healthy animal : *Nourishment*—good ; ∴, the animal is able to walk and rise easily and is free from pain and shivering. *Coat*—is bright, glossy, free from boils, scabs, sores &c. *Eyes*—bright. *Mouth ana Nostrils*—red, moist and free from any discharge. *Tongue*—not hanging out. *Breathing*—quiet, easy, regular and free from bad odours. *Excreta*—natural. *Pulse*—regular. The average *weight* (as indicative of condition) should be: Buffalo 500 to 700 ℔, Bullock, 150 to 225 ℔, Cow 200 to 300 ℔, Ox 353 to 400 ℔, Sheep 20 to 35 ℔.

Is it the meat wanted?—To decide this, examine—(1) *Bones*, (2) the *Tongue*, (3) *Viscera*, (4) the *Flesh*. Horse flesh is deep red with a brownish cast; beef is deep red; mutton is red or dark red; pork and veal are pale. (5) *Fat*: That of horse is yellow and soft; of ox, is hard, and yellow only in old animals; of mutton, white, hard; of pork, soft and white.

Characters of good meat:—*Colour*:—Bright red, neither pale pink (which is a sign of disease) nor deep purple. *Appearance*: marbled (from presence of fat). The *fat* should be firm and whitish-yellow, free from blood stains. *Consistency*: firm and elastic (*i. e.*, not pitting on pressure) and scarcely moistening the touching fingers. *Odour*—faint but agreeable. *It should not* shrink or waste much on cooking; not run to water or become very wet on standing for a day or two; nor lose more than 70 to 74% weight when dried at a temperature of 212°F. *Reaction of oozing juice*—acid. *Marrow*—is of light red colour. [*Meat in incipient decomposition*—is pale, soft, stinking, inferior looking, brittle and smeary; its juices no longer acid in reaction and the connective tissue between muscles or their fasciculi looks greenish. Boiling good meat with fresh lime water yields faint ammoniacal smell; but tainted meat yields offensive ammoniacal odour].

Table of appearance of bad meat:—

Muscle is—	*Indications*:
Pale, moist	Animal is young.
„ wet, flabby	Dropsical meat.
Dry, black	Decomposed.
Greenish	Advanced decomposition; animal over-driven or tired before slaughter.
Purple	Fever or imperfect bleeding.
Bluish	Poor beef.
Fat is.—	
Absent	Youth, disease, bad condition.

Is it from a Diseased Animal?—Decide this, by—

1. *Naked eye* examination of—(*a*) the meat : look for—hydatids, cretified trichinæ, oedemata, extravasated blood ; (*b*) condition of skin and of prevertebral lymphatic glands ; (*c*) condition of intestines, liver, spleen and lungs.

2. *Microscopic* and *Bacteriological* examinations.

3. *Inoculation* experiments on animals.

The Parasites found in Meat :—

	Name of Parasite.	*Sites where to look for them.*	*Naked eye appearances.*	*Animals affected.*
Animal.	TRICHINÆ.	Where muscles are attached to bones, muscles of diaphragm, belly, neck, eyes, larynx, intercostals, root of tongue.	Depends on age of the trichinæ. A nodule containing fluid, and the parasite curled up ; it may get calcified in time.	Pork, cat, dog, bear, (sausages) Pigeons.
	Cysticerci or Bladder-worms. The Measles. HYDATIDS. =non-sexual youthful tape worms.	Conjunctivæ, muscles and other parts of body. Root of tongue (swine), heart and masseter muscle (ox), liver and lungs.	Sac filled with fluid, of the size of pea to cherry. The muscle is pale, soft ; flabby, moist (∴slippery) sometimes calcified.	Swine, ox, sheep, hare, rabbit, dog, fish, buffalo.
Vegetable.	TUBERCULOSIS (Pearl Disease)	Serous membranes Lungs and other viscera, Lymphatics	Small or large granulated tumours of pearly appearance.	Ox, swine, Poultry (very rare in sheep, or goat).
	GLANDERS (Morve) Malleus Humidus	Nasal septum, Lungs, Skin, Spleen.	Nodes surrounded by swollen lymph glands.	Horse, goat, sheep.
	ANTHRAX	Spleen (enlarged and brittle)	Haemorrhages into Spleen, liver, kidneys	Ox, sheep.

(1) The source of infection in man by the TÆNIA ECHINOCOCCI is the dog ; the dog voids the eggs (oncospheres) on hay, straw,

grass or water which are consumed (uncooked) by the cattle or by man. The *trichinæ* resist salting, smoking and careless cooking. Only cooking through the centre kills them. *Psorospermia* or Rainey's capsules outwardly resemble the trichinæ but are harmless if eaten. (2) Milch cows suffer from TUBERCULOSIS much more than oxen, heifers or bulls. Tubercular deposits are seldom found in muscle—but are found in glands. From a tubercular carcass, butchers quickly remove and dispose of the viscera and remove the glands (except the submaxillary and pre-auricular and post-pharyngeal) and strip the pleura from the ribs and remove the diaphragm;—hence, a carcass with these missing, should be condemned. *The following tubercular lesions in a carcass entitle its destruction*:—(*a*) lesion anywhere in an emaciated carcass; (*b*) miliary tuberculosis of lungs; (*c*) lesions in pleura or peritoneum; (*d*) lesions in muscles or lymphatics. Lesion localized in lungs or liver or pharyngeal or thoracic lymphatic glands do not render the entire carcass unfit. *Places where to look for evidence of tuberculosis*: Popliteal glands, knee-fold glands, superficial and deep inguinal glands, internal iliac glands, lumbar and renal glands, precapsular glands, glands of superior and inferior thoracic walls, upper middle and lower cervical glands.

Systematic Inspection of a carcass in the slaughter house: HEAD.—Examine externally for actinomycosis. *Lips*, *Gums* and *Mouth*—for foot-and-mouth disease. *Tongue*—for actinomycosis and foot-and-mouth disease. *Glands* beneath external and internal masticatory muscles—for cysticerci, tuberculosis and actinomycosis. "THE SLINGS": *Lungs*—for tuberculosis. *Mediastinal and bronchial glands*—for tuberculosis. *Heart* (inside chambers)—for cysticerci, inflammations. *Liver* and *Portal glands*—for abscess, inflammations, cysts, tumour, tubercle, flukes. SPLEEN and GLANDS—for tuberculosis, echinococci. MESENTERIC GLANDS—for tuberculosis. PERITONEUM and PLEURA—for "grapes." DIAPHRAGM—should be lifted up to expose concealed tumour or inflammation. STERNUM, VERTEBRAL COLUMN, OS PUBIS—for tuberculosis and osteomyelitis. [Inspect, palpate and incise each part].

Meats fit for rejection : (*a*) Calves unborn or aborted or that have not yet got 8 incisors. (*b*) Cows and oxen weighing less than 200 kilos. (*c*) Male breeding animals. (*d*) Hunted or baited animals. (*c*) Flesh of animals that have died a natural death or from apoplexy. (*f*) Meat affected with distomum hepaticum, echinococcus, actinomyces, trichinæ ; meat that is saturated with blood or oedematous fluid or of a yellow or other anomalous colour or of abnormal taste and smell. (*g*) Meat of animals affected with glanders, tuberculosis, splenic fever, malignant oedema, septic processes, foot and mouth disease, tetanus, chicken cholera. [Remember that--(1) It is permissible to eat flesh of animals in single organs of which vesicles of parasitic disease or pathological changes may be found. (2) Flesh of rabid animals does not contain the poison.]

POULTRY.

Good Poultry flesh –should be firm, pink, or yellowish in colour, fairly plump and should have a strong skin.

Stale poultry flesh—is flaccid, bluish in colour, green over the crop or abdomen, of disagreeable odour and the skin breaks readily.

Signs of Healthy Poultry : active, *Eyes—Nostrils*—dry, *Feathers*—glossy, *Combs and wattles*—firm, brilliant, red. [*Age* is indicated by duskiness of combs and gills, dulness fading and brittleness of feathers, ragged feet and size of claws. *Tuberculosis* is indicated by yellow spots in lungs and liver, *Chicken cholera* (which affects fowls, ducks, geese, pigeons, turkeys &c., and in which diarrhœa may not be present) is indicated by drooping of feathers, swaying of the bird from side to side, also, the fowl drags its legs, drinks much, its comb is flaccid and livid].

Diseases communicated by poultry meat : (1) Tuberculosis (lungs, liver), (2) chicken cholera, (3) Roup.

FISH.

Signs of Staleness. [Fresh fish is firm and stiff.]

Sp. Gravity.—It floats in water. *Eyes*—are sunken and their cornea grey or dull ; their surroundings are reddened. *Gills.*—Pale yellowish or greenish red ; slimy ; smell unpleasant [Beware of fraudulent colouring. Gills are artificially coloured and eyes are made prominent by a small stick fixed transversely in the head].

Skin—discoloured. *Scales*—dull and damaged. *Tail*—droops.

Flesh—flaccid ; pits permanently when pressed ; pressure may even separate the loose skin from the flesh which comes off easily from the bones. Reddish discolouration noticed along back bone. Abdominal wall pulpy, soft, discoloured.

SHELL FISH.

Boiled crabs. If bad are—sticky and web under large claws.

Lobsters and Crabs. Examine under the apron and tail to find discolouration of decomposition.

Molluscs. Only fresh ones are edible. The tests of freshness are : (*a*) The shell should be tightly closed ; if slightly gaping, it should close on being handled. (*b*) When they are opened with a knife, the shells should forcibly close upon the oyster—the tighter the better. Bad cockles are thin and when squeezed, do not squirt any fluid.

EGGS.

Tests of freshness : (1) Seen through towards the sky, an egg is translucent at the centre, and not at the ends (which bad eggs are) (2) Good eggs quickly sink in briny water (5 to 10 % salt).

TINNED* FOOD STUFFS (ANIMAL).

Examine their contents in regard to—(1) their *smell* and *taste* ; (2) nature and amount of *metallic colouring* matter and *preservatives* added ; (3) possibility of *contamination* by the vessel containing it, e.g., copper, lead, tin, zinc ; (4) presence of *parasites* (echinococci, trichinæ etc.)

***Food preservation** : (1) By *cold* storage in freezing chambers. (2) By *drying* in the sun or over fire. (3) By *salting* in a mixture of 1 saltpetre, 32 salt, 2 sugar. (4) By *pickling* in syrup, vinegar, brine, oil etc. (5) By *smoking* (6) Sterilizing in *steam* and then

Suspicious packages are those that are stained or bulging or have two solder marks on the end. As the chances of metallic contamination increase with the age of a package, suspect age from—presence of rust spots showing through label, scratched tin or dirt.

MILK.

[Cow's milk should not have less than 12·5% of total solids, of which 3·5% is fat, and 0·7% is salts; and not less than 10% cream by volume. Milk should never be allowed to be stored in vessels of lead, zinc or copper nor in unclean pails. Keeping milk in close, mouldy room or in dwelling rooms or sick rooms is bad].

Appearance: It should be *white*, with a slight *yellowish* cast, opaque, homogeneous, without flocks or clots. [(*a*) Yellow, red or blue colouration is due to micro-organisms or to contamination by cowdung. (*b*) Slime or flocculi may be due to bacteria, pus, blood, epithelium &c. (*c*) If milk is yellowish, insipid, slightly saline and contain flocculi—it is probably colostrum. (*d*) Bitterness is bacterial].

Sp. Gravity (with Quevenne's Aræometer or Lactoscope) :—It is 1030 to 1032. Stir up the whole quantity and let all froth

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packing in tin cans. (7) By adding *Chemicals.*—(See Author's Jurisprudence): Borax, boric acid, salicylates, benzoates, formalin, sodium chloride, saltpetre, vinegar, ammonium chloride, calcium sulph., alum, spirits of wine, sulphurous acid, bisulphite of lime, copper sulphate etc. This last means should be penalized by law, for the addition of *any* preservative is deleterious to the consumer of the preserved food in three ways, viz., (1) by reason of the unwholesome state of the food which the preservation seeks to hide; (2) owing to the total amount of the various preservatives he may have to swallow along with his serveral dishes; and (3) in consequence of the additional burden thrown on the kidneys to excrete them, not to speak of the positively poisonous nature of some. Formalin(=40% solution of formaldehyde), copper salts and salicylic acid are positively harmful. The limit of these preservatives is :—salicylic acid—1 gr per pint or pound; boric acid, 0·25 to 0·5% in cream and butter.

subside before sampling. If *new* milk marks below 30° or above 34° ; if *skim* milk below 33°, *centrifugalized* milk, below 33·5°—it is suspicious. [Note, at the same time, (*a*) the atmospheric temperature and that of the milk, (*b*) the times of examination and of milking, (*c*) the state of the health of the cows, and (*d*) their time of feeding]. **Reaction**—alkaline or neutral Any commencing acidity is masked by addition of soda bicarb ; excessive acidity indicates souring or addition of preservatives ; excessive alkalinity indicates decomposition or addition of alkalies to hide commencing sourness. **Smell**—may be due to the cow's feeding on half-decayed fodder or rancid oil-cake, spoiled potatoes &c. ; or to decomposition of milk. Odours are more readily absorbed when milk is cold. **Taste**—rancid or bitter from the cow's feeding on bad or decomposed food stuffs. Saltishness indicates recent recovery from inflammation of udders or addition of soda bicarb.

Microscopic Examination—[*Normally*, (1) milk inside udder is sterile, but when drawn with care, it may reveal 100 bacteria to the cc ; and (2) some leucocytes are always found in milk]. Presence of —(1). *Leucocytes*—20 or more in an ⅙ objective field—indicate pus (tuberculosis ?) (2). *B. coli*, *b. enteridis sporogenes*—indicate foecal contamination (cow's or human). (3). *B. Klebs-Loeffler*, *of Scarla-, tina or, of Enteric*—indicate use of polluted water, unclean hands or suffering agents. (4). *B. Tuberculosis*, *Streptococci &c.*=inflammation of breast ; manurial pollution. *Safety-limit of Microbic Contamination is* :—500,000 per c. c. in raw milk and 50,000 per c. c. in pasteurized milk. Milk with not more than 10,000 tubercle bacilli may be sold, provided it is delivered at a temperature not exceeding 10°C. [Bacteria multiply more rapidly the warmer the milk. Enquire—source of **water supply** for the dairy.]

GHEE :—If bad it turns rancid and emits offensive smell.

BUTTER :—Good butter is tough, *watered* butter is brittle. [Water is introduced into butter and fats by mixing with it soap or lye ; The amount of water should not exceed 16% by weight and fat should constitute at least 80%. *Rancid fats* are introduced to increase volume].

GRAINS AND GRANARIES.

Granaries and Godowns—should be dry, airy and built in cement concrete, with insect-proof doors and windows. Anything that helps to make the grains wet, mouldy or fermenting (and therefore poisonous to man) should be avoided. The grains and pulses should be stored in clean dry bags and kept clean, rats and vermins being rigorously excluded.

Microscopic Differentiation of Starch Grains.—I. GRAINS ARE SINGLE—(1). *Roundish lumpy or lenticular* stratification exists at most at the margin = Wheat, Barley, Rye. (2). *With indistinctly crystalline surfaces*, sharp-edged, with a non-stratified nuclear cleft = Potato, Banana, Wheat, Rye. II. GRAINS ARE COMPOUND or have many surfaces—(1) *Those with many angular granules* = Rice, Oats. (2) *Granules roundish, polygonal, united into small aggregations* = Buckwheat. (3) *Granular, isolated, large, angular* = Maize. (4) *Grains composed of 2 to 4 granules which are partially broken* = Sago, Manihot, Sweet potato.

Diseases of Grains : (1) *Anguillula Tritici*—found in masses in wheat, in damp seasons ; the grains become small, short, thick, blackish, indistinctly three-cornered. (2) *Ergot* = the permanent mycelium (sclerotium) of a fungus, *secale cornutum*, which grows at the expense and in place of a grain of corn. (3) *Ustilagineae* (Smut, canker etc) are fungi which destroy the grains. Ground with flour, they cause disagreeable odour and diarrhœa. *Microscopically examine grains for fungi.*

Unsound Grains : *Smell*—mouldy. *Taste*—irritating. *Microbes*—abundant. *Hyphomyceles*—several. [Presence of 18% *moisture* is undesirable]. For Ergotism, Pellagra etc.—See Author's Medical Jurisprudence, 4th Ed.] Presence of—*Acarus farina* = flour is about to change. *Vibrions* = flour is fermenting.

Rice :—Old and new rice, country and Burma rice, broken and diseased rice and entire good grains—are frequently mixed up—being uniformly coloured by lime or chalk. Look therefore for (*a*) broken grains, (*b*) grit spots, (*c*) evidence of insects.

FLOUR.

Sound Flour has these characteristics : *Colour*—pale cream. *Appearance*—well dressed. *Feel*—smooth (not gritty, lumpy or greasy). If a handful is compressed, it should bind slightly, taking the form given it. *Odour*—pleasant. *Taste*—pleasant and mild and when made into *dough*, it should stick well together and draw out into long strings. It should not contain more than 15% water and not less than 10% gluten of good quality.

Faults : Even fresh flour always contains rather numerous spores of *mould* and *bacteria.* (2) Keeping flour in damp places, causes its starch to be converted into *sugar* and then into *lactic* and *butyric acids* ; and its proteid into *peptones* and poisonous fission-products of the latter—even *poisonous alkaloids.* (2) In summer, flour may become warm, the gluten being rendered "*short*", i.e., not easily forming sound dough, unless ground over again with an addition of sound flour.

BISCUITS :—*Colour* : Paleness or whiteness means age or imperfect baking. *Weevils* and *moulds*, if present, indicate the use of unsound, musty flour. *Rancidity* affects rich biscuits stored long.

BREAD :—[CRUST—should be of brownish yellow tint, well baked. CRUMB—should be evenly distributed, light and flaky, neither too brittle nor too doughy. If lightly pressed, it should regain its original position. Its colour should be creamy white, taste and smell pleasant. Bread should be thin].

DEFECTIVE BREAD :—

Signs.	*Cause.*
Very white, light, brittle	Alum has been added.
Badly risen, acid, yellowish	Fermented or old flour.
Large size, insipid taste, not firm	Salt insufficient.
Saltish, compact	Salt excessive.
Sour	Dirty utensils, yeast stale or inferior, unsound ; or low grade flour.
Sodden, heavy	Bad yeast, inferior flour, badly kneaded dough, too hot oven.

GREEN VEGETABLES :—See if they have been watered with clean or foul water. Ascertain the fields from which they have been gathered.

FRUITS.

(A) **Fresh.**—Reject over-ripe and unripe ones.

(B) **Dry**—Look for dirt, mould, mites.

(C) **Preserved in Boxes** : Look for—(1) Signs of *fermentation*—by change of taste and smell and formation of bubbles of CO_2. (2) *Decomposition* (ptomaine formation) and formation of moulds. (3) *Metallic* contamination—by copper, lead, tin, zinc, arsenic, coal tar dyes. [Those preserved in oil are much richer in lead].

ÆRATED WATERS. Reject bottles showing sediments or weedy growths. Test Lemonades, for presence of lead.

TEA :—Estimate the total soluble matters, to judge of adulteration : this should be at least 30% in good tea. To judge if tea is good, pour boiling water over the leaves and see whether it is a small whole leaf or a large leaf cut into small shreds.

COFFEE :—Chicory is a lawful adulteration of coffee ; when coffee is thrown into water, it floats ; while chicory sinks, leaving a tell-tale brown trail behind it.

WINES AND SPIRITS.

Take (1) the *Sp. Gravity* of the beverage by a hydrometer or specific-gravity bottle and by reference to tables find out the per centage of alcohol corresponding to this sp. gr. ; (2) *Acidity* by decinormal alkali solution ; fixed acids (as in brandy) being expressed as tartaric acid, volatile acids as acetic acid ; each cc. of decinormal solution = 7·5 mgrms tartaric and 6 mgrms acetic acid. Law permits whisky, brandy and rum to be sold 25° and gin 35° underproof.

ANALYSIS OF CERTAIN FOOD STUFFS.

(*Minerals*, *refuse* and *water* have been omitted and the figures indicate so much per cent. *P*=Proteid, *F*=Fat, *C*=Carbohydrate, *Cal*=Fuel value in calorie per pound).

Meats—	P.	F.	C.	Cal.
Beef (sirloin)	16·5	16·1	...	975
Veal (breast)	15·4	11·0	...	745
Mutton (flank)	13·8	36·9	...	1770
(hind leg)	15·1	14·7	...	890
(loin)	13·5	28·3	...	1415
(fore quarter)	12·3	24·5	...	1235
(hind quarter)	13·8	23·2	...	1210
Lamb (breast)	15·4	19·1	...	1075
Goat	24·06	2·5	...	...
Pork, Ham	13·5	25·9	...	1320
Smoked Ham	14·2	33·4	...	1635
„ Bacon	9·1	62·2	...	2715
Chicken	12·8	1·4	...	305
Fowl	19·72	1·42	...	765
Turkey	16·1	18·4	...	1060
Raw meat juice	1·8	...	...	9
Goose (Fat)	15·91	45·59	...	...
Partridge	25·26	1·43	...	...
Egg	12·55	12·11	0·53	...
Cheese	28·21	27·83	2·50	...
Fish—				
Rohu (rooi)	17·5	7·4	...	137
Magoor	18·9	5·4	...	105
Perch	12·8	0·7	...	275
Shad	9·4	4·8	...	380
Herring (smoked)	20·5	8·8	...	755
Salmon (canned)	21·8	12·1	...	915
Sardines („)	23·7	12·1	...	950
Oysters	6·0	1·3	3·3	225
Crabs	7·9	0·9	0·6	200
Lobsters	5·9	0·7	0·2	145
Sole	11·94	0·25	...	...
Milk—				
Human	2·97	2·90	5·87	...
Cow, English	4·0	3·7	4·8	...
Bengal	3·55	3·69	4·88	...
Bazar (mixed)	2·57	2·27	2·60	...

Milk—	P.	F.	C.	Cal.
Buffalo	4·40	9·0	4·8	...
Goat	3·62	9·0	4·8	...
Ass	1·79	4·20	4·0	...
Ewe	7·10	1·02	5·50	...
Mare	1·99	1·17	5·70	...
Condensed Milk	9·68	8·90	54·53	...
Butter milk (cow)	3·0	0·5	4·8	160
Skim „ „	3·4	0·3	5·1	165
Cream	2·5	18·5	4·5	865
Butter	1·0	85·0	...	3410
Cheese	27·7	36·8	4·1	2075
‘Chhana’	24·06	2·5	...	...
‘Sandesh’ (best)	18·17	19·75	40·18	...
Cereals—				
Rice (Sunbaked)	6·83	·7	79·2	...
(Parboiled)	6·71	·9	80·1	...
Darbhanga	10·06	1·08	76·24	...
Wheat flour, whole	13·8	1·9	71·9	1650
„ (roller)	11·4	1·0	71·5	1635
‘Atta’	13·40	2·4	67·1	...
‘Maida’	11·0	2·0	71·2	...
Macaroni, Vermicelli	13·4	0·9	74·1	1645
Juar atta	7·64	2·32	68·23	...
Bajra atta	7·23	1·86	71·47	...
Buckwheat	8·75	1·24	75·73	...
Tapioca	0·4	0·1	88·0	1650
Barley	12·7	2·0	71·0	...
Pearl	7·3	1·1	75·8	...
Maize	10·0	6·7	64·50	...
Oatmeal	12·6	5·6	63·0	...
Puffed Rice (khoi)	5·7	...	50·0	228
Bread, white	9·2	1·3	53·1	1200
Brown	5·4	1·8	47·1	1040
Whole wheat	9·7	0·9	49·7	1170
Cream cracker	9·7	12·1	79·7	1925
Pulses—				
Moong (yellow)	23·8	2·0	54·8	...
(green)	22·2	2·7	54·1	...
Masoor	25·1	1·3	58·4	...
Makustha	23·8	0·6	56·6	...
Arhar	21·67	3·53	54·27	...
Matar	22·01	1·96	53·97	...
Mas-kalai (urid)	22·7	2·2	55·8	...
Kulathha Kalai	22·5	1·9	56·0	...

Pulses—	P.	F.	C.	Cal.
Khesari	31·9	·9	53·9	...
Gram	21·7	4·2	59·0	...
French Beans	22·5	2·0	58·0	...
'Barbati'	24·1	1·3	56·8	...
'Sheem'	20·5	2·2	5·35	...
Indian Bean (dry)	22·0	1·5	57·5	...
Soya „	3·02	2·13	1·88	...
Matar Soonti	8·3	·87	22·43	...
Roots and Tubers—				
Jack fruit seed	13·14	1·98	34·18	...
Potato	2·0	·16	21·0	295
'Chupri Aloo'	·98	trace	16·10	...
Sweet Potato	1·57	·32	22·50	...
Sank Aloo	1·54	·29	21·00	...
Carrot	0·5	0·3	10·1	...
Beetroot	1·3	0·1	7·7	160
Garlic	6·76	·06	trace	...
Sago	1·6	0·3	8·3	...
Man Kachu	·25	trace	11·20	...
Goori „	1·12	·20	19·23	...
Arrowroot	5·06	...	82·00	357
Sati	5·62	...	72·	318
Paniphal	8·56	...	74·77	388
Sugars—				
Kashi Sugar	...	...	94·48	...
Crystal sugar	...	...	97·0	1750
Molasses	...	...	70·0	1225
Sugar Candy	...	...	96·0	1680
Honey	...	...	81·0	1420
Fruits.				
Red Gourd Chal	·18	...	1·22	...
Bilati *	·25	...	3·87	...
Apples*	0·3	0·3	10·8	190
Bananas	0·8	0·4	14·3	260
Grapes	1·0	1·2	14·4	295
Lemon	0·7	0·5	5·9	125
Musk melon	0·3	...	4·6	80
Oranges	·82	13·64	11·66	150
Water melons	0·2	0·1	2·7	50
'Dalim' *	·61	...	6·50	29

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* Free sugar is present

Fruits.—	P.	F.	C.	Cal.
'Bedana' *	·98	...	6·60	35
Unripe plantain	·50	·26	3·25	...
Papaya (unripe) *	·56	...	3·47	...
Pineapple *	·58	5·00	7·25	...
Apricots	4·7	1·0	62·5	1125
Date	1·9	2·5	70·6	1275
Figs	4·3	0·3	74·2	1280
Raisins	2·3	3·0	68·5	1265

Nuts.

Almond	11·5	30·2	9·5	1515
Chestnut	8·1	5·3	56·4	1385
Cocoa(nut)	2·9	25·9	14·3	1295
Walnut	7·2	14·6	3·0	730
Pistachionut	22·7	51·1	2·5	
Cacao	14·76	49·0	13·31	
Earth Nut	24·5	50·0	4·5	
Indian Badam (dry)	4·08	56·86	6·56	

Invalid Food.	P.	F.	C.
Allenbury No. 1 †	9·7	14·0	66·85
„ „ 2 †	9·2	12·3	72·1
„ „ 3 †	9·2	1·0	82·8
Horlick's Malted Milk†	13·8	9·0	70·8
Carnrick's Soluble Food	13·6	2·5	76·2
Glaxo †	22·2	27·4	41·0
Milo Food	14·4	5·2	75·3
Mellin's Food †	7·9	...	82·0
Savory & Moore's †	10·3	1·4	83·2
Benger's Food	10·2	1·2	79·5
Neave's Food	10·5	1·0	80·4
Frame Food Diet	13·4	1·2	79·4
Bananina	4·1	0·40	84·0
Hovis No. 1 †	7·7	0·20	86·6
„ No. 2	5·7	0·10	90·1
Robinson's Groats	11·3	1·6	75·0
Patent Barley	5·1	0·9	82·0
Chapman's Whole Flour	9·4	2·0	79·3
Nestle's Food	9·85	3·67	79·61
Swiss Milk	9·93	8·85	63·70

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†*No Starch Present.*

**Free sugar present.*

Wines and Spirits.	Percentage of Alcohol.	Percentage of Sugar.
Sherry (*Acid*)	22·90	1·88
Port (*Acid*)	21·91	6·42
Marsala	20·44	3·48
Madeira	19·11	3·46
Tokay	12·74	14·99
Champagne (*Sparkling*)	11·75	11·53
Burgandy (*Astringent*)	11·00	...
Malaga	14 to 18	16·37
Hock	8 to 11	8·49
Claret (*Astringent*)	8 to 12	...
Cider and Perry *diuretic* and *laxative*	5 to 9	...
Porter and Stout (*Malted*)	2 to 5	...
Beer and Ale (*Malted*)	2 to 5	...
Brandy and Cognac	43 to 57	...
Rum	51 to 59	...
Whisky	51 to 59	...
Gin and Hollands	48 to 56	...

Antiscorbutics. Percentage of citric acid :—

Lemons (Patee)		6·5	
„ Kagji		6·4	
„ Gora		5·6	
Tamarind	Citric acid	2·20	...
	Tartaric „	6·63	...

Peptone Preparations.	Soluble proteid.	Extractives and non-peptone organic matters.
Somatose	80·	...
Carnick's Peptonoids	24·0	65·4 (Sugar)
Liebig's Peptone	33·40	24·6
Armour's Wine of Peptone	3·0	12·9
Panopepton	3·0	15·0 (Sugar)
Valentine's Beef Juice	9·65	11·16
Puro „ „	30·33	19·16
Brand Wyeth „	15·45	16·55
Armour Beef Juice	8·3	9·54
Liebig's Extract of Meat	9·4	48·6
Bovril	16·94	20·32
„ Invaild's	21·42	39·60
Brand's Essence	10·43	1·01

EATING HOUSES.

In India there are three classes of restaurants : (*a*) Superior class of "*Hotels*" maintained by and for Europeans ; (*b*) Indian *Boarding Establishments* intended for high class boarders ; and (*c*) *Eating Houses* frequented by the poor. Besides these, there are a host of other establishments which are not regular eating houses but places where articles of food are manufactured, stored or sold; such are the *tea houses*, the *sweetmeat* vendors' shops, the *bakeries* etc. In considering all these, regard must be paid to the Indian custom of squatting on the floor at meals, the proverbially dirty condition of cooks and servants and the frequent habit of using the same room for serving customers and for sleeping at night.

The following rules must be rigidly enforced in respect of all public houses where food is sold or served :—The *surroundings* should be sanitary—away from stables, from dark, damp lanes seething with rotting garbage, from privies, from open drains etc. The *rooms used* must be well-ventilated, well lighted, free from damp, and if possible, situated on high floor. They should not communicate with the kitchen or the privy, nor a portion of them be used as store or kitchen or as passage into the premises. *Floor*—must be made of cement on concrete without any patterns being worked into the ground and the floor must be kept in good state of repair. *Walls* must be lime washed twice a year. *Coke, coal, firewood*, *charcoal* etc. must be kept in a covered metal bin or metal-lined wooden bin in a place to be pointed out by the Health Department. *Water*—must be stored in suitable covered metallic receptacles at situations specified by Health Officer. *Articles of food*—must invariably be stored in glass cases or wire-gauzed clean safe, in places free from dust, flies, vermins, damp and exhalations. *Proper washing place* must be provided, which must be supplied with filtered water only, which must be well cemented and drained to half pipes, the latter discharging over a gully at least 18 inches away from any drain inlet. *Dust bin* must be covered and situated at specified spot. *Tables* must be topped with marble or zinc. They must be daily washed with hot water and soap. *Kitchen*—should be so situated as not to communicate with serving-room and no article of food must be kept on the floor before or after its preparation. *Persons* engaged in preparing food or serving the same, must be free from skin diseases and dirt and the evil *practices* of covering food with a greasy napkin, of using a universal mop for scrubbing all dishes, of immersing a dirty lota into the water reservoir, of perfunctorily cleaning the tables after use, of using the eating places for sleeping at night, of exposing prepared food to the dust and the flies, of stuffing bundles of odds and ends here and there in the rooms, of allowing cobwebs, cockroaches, rats and vermins—these must be put down by frequent inspections.

CHAPTER XVII.

DISPOSAL OF REFUSE.

Refuse—comprises—(*a*) all useless articles and (*b*) waste products—whether solid or liquid. But, for practical purposes, the dry waste is called refuse and the liquid is called sewage.

Sewage is the *mixed* solid and liquid excrementa from houses, cowsheds, stables and factories. *Slop* is the waste liquid from kitchen, bed room vessels &c, *Sullage* is waste water from houses, without solid fœces.

Nature and kinds of refuse are shown in the table below :—

	Dry (Refuse)	Liquid (Sewage).
Domestic	Ashes, food remains, sweepings, fœces of men and animals.	Water due to washing body, clothes, dishes, floors ; lavatory, bed-room, privy and kitchen slops, rain water ; stable etc. washings.
Public	Street sweepings, household refuse, animal droppings, slaughter house and trades and factory waste.	Rain water, public bathing and latrine slops, slaughter-house and factory slop.

Necessity for removal : (1) To preserve **health** ; for, unless removed, refuse tends to vitiate—(*a*) *Air*—by giving off into it noxious gases and odours and germs and their spores ; (*b*) *Water*—by giving up into it harmful chemicals and bacterial and other organic matters ; and (*c*) *Soil*—by circulating through it, with all its gaseous and bacterial contaminations.

(2) To utilize it all to **profit** and advantage—such as by *reclaiming* swampy lands or by selling it as *manure* after mixing earth with the excreta or by selling it to manure makers, cultivators, *brickmakers* &c.

Excretal refuse may give rise to diseases thus :—(A) *By direct contact* and conveyance of infection by hands, by clothing of persons whose bowel discharges contain pathogenic germs or who infect their hands, clothes, utensils, etc. by using water or food infected. (B) *By mediate conveyance* of infection by means of (*a*) vapour and gases ; bursting of bubbles at the surface of sewage and separation of dried particles from walls of sewers and pipes cause ejection of bacteria into the air ; such air entering premises has caused disease ; (*b*) dust and suspended matter in air —in India enteric bacilli survive in dust, contaminated with infected urine, for 5 days ; such dust deposited on food may produce disease ; (*c*) flies and insects—as is well known ; (*d*) specifically infected soil and water—typhoid bacilli living in water 9 weeks and in soil 74 days.

Means of Removal : By (1) The Dry System (which includes *Scavenging* and *Conservancy*) and (2) *Water Carriage* system. They are available according to the nature of the refuse as follows :—

	Kinds of Refuse.	Means of Removal.	How disposed of
Dry	Dry human foeces	Scavenging, Conservancy, Water carriage	As manure ; soil trenching ; discharge into sea.
	Dung, ashes, dust, refuse, food, street sweepings.	Scavenging	Dumping, Incineration.
Liquid	Domestic soiled water	Water carriage	Discharge into a stream after purification.
	Rain water, Trades and manufacture slops	Do.	Do.

The best means is that which is (*a*) the quickest, (*b*) the earliest—*i. e.*, does not cause accumulation near houses, (*c*) the least productive of nuisance and (*d*) requires the least handling.

In places where the dry system prevails, slop and waste waters are allowed to communicate with holes dug in one's garden or with ditches, cess pools or streams. On this account, the dry system may suit isolated houses but is rather insanitary for towns. Where however, it has to be applied to small rural municipal areas, care should be taken to keep the dry from the *liquid* refuse. A tank may be dug away from the town, all the liquid refuse collected in pails tipped into it and mixed with sulphuric or hydrochloric acid, so as to get the ammonia. The *dry* refuse may be used for dumping or as fuel for heating and the *sludge* of this tank dried and sold as 'poudrette.'

Insanitary practices in India : Every form of filth is thrown into the public streets and at all hours of the day and night, including excreta of children. Bathing and washing the mouth, clothes and cattle, allowing overflow of one's gullypit, spitting, clearing the nose, even easing onself—go on without let or hindrance, on the public streets as well as into potable waters. Shopkeepers, like householders, throw out their refuse, solid as well as liquid, into the streets. Public baths are used also for washing clothes and easing oneself. Public urinals and latrines are also recklessly used. Cooking utensils, milk pots, water pails—are scrubbed with rubbish by scraping the road anywhere and often washed in the nearest puddle. The nates of children are washed, after they have eased themselves, near or at, the nearest hydrant or unfiltered water tap ; and, in villages, persons ease themselves on the bank of the potable tank and then wash themselves in it !

(A) DRY SYSTEM OF REFUSE REMOVAL.

This comprises—(1) Scavenging, (2) Conservancy.

I. SCAVENGING.

This *refers to* removal of dry refuse (*a*) by sweeping or scraping and (*b*) without much attempt to get direct profit out of it. It is *applicable only* to dry refuse (household or public) and excludes human foeces; it is *done by* sweepers, carts, waggons etc. It comprises *three stages* :—collection, removal and disposal.

I. **Collection** : Methods vary according to the nature of the refuse :—

1. *Domestic dry refuse.*—Householders are expected to store their day's refuse in covered dust bins in a corner of their compounds and to empty the same into street dust bins at hours fixed by the sanitary authorities or into scavenger's cart, when the latter calls round. To avoid decomposition, it is advised to burn to ashes easily destructible matters (like potato peelings etc) in the kitchen-fire at the end of the day, or, to sprinkle "pesterine" or ash or dry earth over the refuse. [Dust Bins should be (*a*) situated on well cemented raised platform, away from rooms and from prevailing winds ; (*b*) *made* of galvanized iron ; (*c*) be of convenient *size* ; (*d*) have well fitting metallic *covers*, so that rain may not get into them ; and (*e*) be cleared of their contents daily. *Brick*-dust-bins absorb moisture and bad gases and can never be thoroughly cleaned ; they are, therefore, dangerous].

2. *Animal dry Excreta* : These are best stored in the very cart in which they are to be removed, as removal from other receptacles into the cart means disturbance of the heap and throwing into the air noxious gases and germs.

II. **Removal.**—(*a*) *Street refuse*—may be removed in open horsedrawn "scavenger's carts" (with metallic or tarpaulin covers) to elevated discharging platforms, whence the contents are discharged into trucks (also covered). In villages, too, they are carried in carts drawn by animals to their place of destination—usually, a swampy land or an undesirable tank &c.

III. **Disposal** of dry refuse is effected in one of two ways:

1. **Dumping**:—The railway trucks convey the dry refuse of Calcutta to the Municipal Square Mile to the east, where they are dumped down, to help in reclaiming the waste land. Each layer of refuse dumped down on to made soil, should be covered over with a layer of clean soil. [The site where such dumping occurs is called the *Shoot*; the heap of refuse dumped is called *muck heap* and the reclaimed soil is called *made soil.*] THE DANGERS of this are: (*a*) *water* courses—in the neighbourhood are polluted; (6) *flies* increase in the locality; (*c*) *rats* swarm in numbers; (*d*) hand-sorting of paper, rags etc. leads to *spread* of dirt and infection. (*e*) Made soil is unfit for *building* for years. ADVANTAGES: Excellent crops of vegetables can be grown out of such soil. [In some places, instead of being dumped or incinerated hygienically, it is (*a*) **burnt in open air** creating nuisance or (*b*) heaped in a **sorting** yard, where it is sorted into breeze, hard core, and soft core and disposed of accordingly.

2. **Incineration** = destruction of the refuse by burning it in close brick chambers so as to reduce the mass into either ashes or clinker (vitrified slag). Incinerators are of two types, as per comparative table below:—

(i) *Low Temperature*	(ii) *High Temperature*
1. It is a coke furnace.	1. Steam blast furnace
2. Incompletely burnt vapours and dust particles have to be separated & completely burnt up before entering chimney-flue.	2. No incomplete combustion occurs in it; hence such double process (and ∴ expenses) are unnecessary.

Low Temperature	*High Temperature*
3. Cremator is necessary.	3. No cremator required
4. Wear and tear is less ∴, less cost in upkeep.	4. Maintenance is costly.
5. 6-8 tons are burnt daily.	5. 10-16 tons daily.

The *site* for installation of Incinerators should be—in the centre of the district, to lessen cost of transit. [Some of the dry refuse of Calcutta is burnt in the Goragatcha incinerator.]

THE SINE QUA NON OF INCINERATORS ARE TWO:—(*a*) Abundant supply of *drying* and *inflammable* material (*e. g.*, saw-dust, coal dust, wood shavings, gas-tar liquor); this must be used *freely* to dry up urine and the moisture of excreta and rubbish. (*b*) Properly designed incinerator which combusts well.

THE ADVANTAGES OF INCINERATION ARE: (1) None of the disadvantages of dumping. (2) The clinker is *sold* for mortar or paving-slab or concrete-brick making. (3) The refuse is *reduced* to ⅓ or ¼ of its original volume. (4) The *heat* generated may be utilized for preparing steam or electric power to pump water or sewage or drive mortar mills. (5) No *nuisance* is produced in the neighbourhood of the incinerator.

DISADVANTAGES. (1) Town rubbish does not burn well and is damp;—hence, greater cost of supervision and fuel; (2) It emits some stench.

II. CONSERVANCY.

This system (**applicable only to** *non*-sewered places and to dry or dried refuse) seeks to remove dry human foeces *in such a way as to make it a saleable article* and therefore, profit-yielding. In India, such a thing is practically unknown and this term is applied to the department dealing with latrines and privies of all sorts.

Commercial Value.—An *European* passes in 24 hours—4 oz (by weight) foeces and 50 fl. oz of urine. The *Indian* passes—12 oz foeces, 40 oz urine and 40 oz sullage water. But as vegetarians pass more and children and women pass less of both, the value of a mixed—

$$\left.\begin{array}{l}\text{Foeces } (2\tfrac{1}{2}\text{ oz})=40\text{ gr N.}\\ \text{Urine } (40\text{ oz})=189\text{ gr N.}\end{array}\right\}\text{ @ } 7s\text{ per year.}$$

And 10 tons of average water-closet sewage equal 12 tons of average privy sewage, from agricultural point of view.

Classification : As found in other countries or in modified forms in India, conservancy work can be carried on according to one of these systems : (1) Midden System (2) Pail System (3) Rural System.

MIDDEN AND PAIL SYSTEMS.

We take up together these two *Hand-Removal Systems.*

Old and New Styles.—In *Europe, in ancient times,* both the midden and pail systems comprised—a private enclosure or privy and a hole dug in the ground ; in the case of middens, foeces were discharged direct into the hole ('midden' meaning a dunghill) ; while, in the case of the pail system, a covered removable bucket or pail, was put into the hole. (2) *Now-a-days,* however, the midden has been abolished, while the pail is found in rural districts only. **The Commode System** found in India is a modification of the pail system.

Disadvantages of Hand-Removal System—(1) It is *expensive*—because an army of sweepers has to be maintained, though the initial cost is not much. (2) Its success depends absolutely upon the way in which sweepers do their work : hence, strict *supervision* is essential. (3) *Wear and tear* of apparatus is great. (4) Night-soil has to be *kept overnight.*

(5) The refuse has to pass through high roads, emitting *odours.* (6) In cases of heavy rain, trenches may be a source of pollution of water supply. (7) Exposed night-soil increases the *fly pest* and thereby fly-spread of excretal infections.

Middens	**vs.**	**Pails.**
1. Being holes in the soil are insanitary.		1. Are more sanitary.
2. Contaminate soil, air and water.		2. Do not do so.
3. Contents decompose quickly.		3. Do not do so quickly.
4. Contents are unfit for manuring (∴ profitless).		4. Fit for manuring after slight treatment.

Pail vs. Service Privy. *In India,*—"Midden" system is unknown and the "Pail" system is represented by the "Service Privy" system,—the points of difference between the two countries being shewn below :—

Service Privy (Indian).	Pail System (English).
1. The *enclosure* is most primitive in design and construction.	1. It is a galvanized iron or masonry work, of proper dimensions.
2. It is often open to the sky and situated on ordinary soil. It is over-*ventilated*, even exposed to wind and rain.	2. It is properly roofed and built on concrete and provides ample ventilation near the roof.
3. *Situated* to the back of dwelling houses, near a tank or well.	3. Situated at least 6 ft. from dwellings and 40 to 50 ft. from wells.
4. The *Receptacle* is an ordinary earthen vessel, situated some feet below the foot-rest, in a chamber whose sides are quite permeable to moisture.	4. It is a well-tarred oak or galvanized iron or enamelled, covered bucket, placed 6″ below the seat, on a raised cemented floor in a chamber impermeable to moisture.

Service Privy (Indian).	Pail System (English).
5. Its *contents* are foeces, sullage water and urine.	5. Its contents are dry foeces covered or not with earth or ash.
6. Part of the *urine* and *sullage water* runs into the receptacle; the rest is allowed to soak into earth, outside enclosure*	6. Urine is collected outside the privy in a separate vessel placed on raised, concreted platform. (No sullage exists).
7. *Floor* is not necessarily cemented nor possessed of incline and is at any height from the ground.	7. Floor is cemented or paved and has ½ to 1 ft incline towards the door. It is at least 6″ higher than the ground.
8. No *trap-door* for sweeper exists, but one side is kept open; and here animals freely enter.	8. Trap door, well tarred, is provided; it is kept shut when not required for service.
9. Indians sit on their feet to defœcate and use water for cleaning.	9. They sit on their buttocks and use tissue paper.
10. *Foot rest* may be too closely placed (∴ sides are soiled) or too widely placed (∴ excreta fall outside the receptacle).	10. Seat is properly adapted to the size of receptacle or vice versa.
11. The receptacle often *overflows*.	11. It never overflows.
12. It is *cleaned* daily.†	12. Cleaned weekly—∴ at least 8 cub. ft. capacity.

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* In non-closeted places in India, all the sullage as well as slop water from individual houses is conveyed away by shallow, open and kutcha trenches dug into the ground, into the nearest open waste or ditch or tank. In rare instances only, chanelled Ranigunj fire-clay half-pipes or cemented concrete drains are used to convey the waste water to proper outfalls !

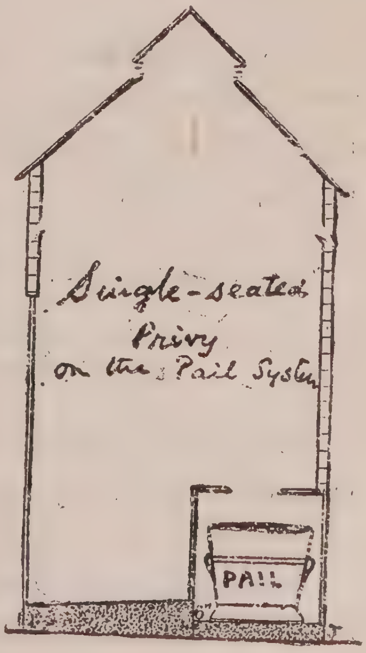
† In the tropics, excreta should be removed as soon as passed. But in some rural municipal areas, the sweeper or mehter is not to be daily seen !

The above table shows, in the left hand column, the wrong way of making privies and, the right hand column shows the right way of making them.

Well privy.—A dangerous magnification of the midden system was to be found in what were called well privies, extant in several Indian villages. A kutcha well was sunk into the soil and on it were placed, in storeys, brick-built privies, from which the excreta, urine and sullage water—all dropped direct into the well or were conveyed into the well by means of pipes. The pipes soon got a coating of foeces and urine ; and, as the wells were never cleaned for generation and were situated within the house, they were a danger to health for ever. They were, however, crude prototypes of our septic tanks : only they were situated inside houses and too near family tank or well.

Where, however, a **midden** must be constructed, it should be *made* of brick, set in cement, its *floor* smooth and above the *level* of the adjoining ground, *capacity* not more than 8 cft, protected from rain and snow and provided with trap-door for regular *cleaning*. The privy above it must also be brick built.

The pail must be of galvanized iron or wood well tarred inside ; its capacity is not to exceed 2 cft and it should have well-fitting lids. It should be set on raised impervious floor in well ventilated pucca privies.



Treatment of Pail Refuse :

I. **If excreta are to be simply deodorised and desiccated :**—the contents of the pail must be kept *dry* and unmixed with other house-refuse*. This can be effected by any of these :—

1. MOULE'S DRY EARTH SYSTEM—is the best. A ℔ and a half of sifted, dry earth is spread over every part of the stool ; this spreading can be effected by (*a*) hand, (*b*) automatically by a sifting device ; or, (*c*) mechanically by a hopper. The "*compost*" thus obtained can be dried and used over again and again, to spread over foeces with the best results. [Sand, gravel and chalk are useless for the purpose ; loamy-surface-soils and vegetable moulds are the most efficient for purposes of deodorizing the stool (by process of nitrification).

2. MORELL'S CINDER OR ASH SYSTEM.—Ash is sifted and automatically thrown into the pail after each act of defæcation.

3. STANDFORD'S CHARCOAL SYSTEM—½℔ charcoal from seaweed is spread over each stool.

4. GOUX'S SYSTEM OF LINING wooden buckets with either (*a*) peat or (*b*) sawdust + soot + tan + charcoal + gypsum.

II. **If intended for manuring purposes**—the contents are best kept *moist*, because urine + foeces, though liable to easier fermentation, forms better manure. There are three processes of preparing it :

(*a*) urine is mixed with foeces ; or, (*b*) urine is mixed with foeces and house refuse	in either case mixed or not with finest earth.

(*c*) urine mixed with foeces is treated with H_2SO_4 and steam to form a dry imperishable powder called *poudrette*.

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* In drying the earth, heating it is to be avoided ; for, heat kills the microorganisms that by their nitrifying action, in the presence of air, disintegrate (or humify) the soil.

RURAL SYSTEM

Indiscriminate Easing Places in India.—Open tracts of land are freely utilized for easing oneself, the more so, if a stream or tank or well is near by—though Hindu religion safeguards public health by insisting that only those parts of open country are to be so used, which lie at the extreme range of an arrow shot on the leeward side of the village. Soldiers on the march, dig 6″ holes into the ground and fill them with loose earth after easing themselves. In cantonments, the excreta are burnt. It is only in municipal areas in rural tracts that the service privy prevails—everywhere else gardens, fields, river banks etc. are the public easing places.

Disposal. Three methods are available in rural areas : (1) The foecal matter may be **dried** and sold as manure at a direct profit. But this is seldom done in India. (2) The liquid foecal matter may be **trenched** ;—that is, poured into trenches dug in places that are porous or loamy and well drained, with moderate amount of rainfall and warm temperature. Trenches should be *situated*—300 yards away from wells or human habitations and from prevailing wind. Trenches may be of any *length*, but only 18 to 24 inches in *width* and *depth* and 2 ft. *apart.* Only 12 inches of sewage or foeces may be laid on, to be covered up with loose dry earth. After three weeks, these areas may be *leased out* to farmers or the foeces mixed with some earth may be dug up and *sold as manure.* A site should not be trenched for more than two years. If a succession of crops can be taken off the area in a year, it can be used as trench in the next, not otherwise. Potato, tobacco, maize &c. grow well on trenched soil. (3) **Pitting system**—is a variation of trenching system, being a modernized midden or a miniature well-privy. Wells 20 ft × 4ft × 4ft are dug in the soil and night-soil is deposited therein to be converted into inoccuous *manure* but of less manurial value. This can be then marketed.

(B) REMOVAL OF SEWAGE BY WATER-CARRIAGE SYSTEM.

Definition and Scope : This system seeks to carry away solid excreta together with, and *borne over*, all *liquid* refuse, (both of them rendered inoccuous)—to some flowing stream or sea. This is also known as the Sewage System.

Its merits : (1) It is the cleanest, readiest and ultimately the cheapest process. (2) It removes both liquid and solid excreta (but not the dry earth, vegetable or animal refuse) *automatically*. (3) It helps to drain off *sub-soil moisture*, specially, if the sewer is brick-built. (4) It does not require constant *attention*.

Disadvantages (1) It is *costly* initially. (2) It requires sufficient *fall* in the level of the district. (3) It requires *periodical hand-cleaning*. (4) If improperly built, it *contaminates soil* and through it, the water supply. (5) It requires good supply of water, good *ventilation* and proper outfall.

Components of Water Carriage System :

1. **Receptacle for** (1) waste waters.	In gully or drain.
(2) Urine and excreta	In water closets.
2. **Conduits** of (1) Waste water and (2) Excreta	By Waste-water-*pipe* and soil pipes (via cesspools, silt chambers traps, inspecting *manholes* &c.)—to
3. **Destination** … …	Public sewers.

1. THE GULLY.

Gully is an open, yard drain,—a gutter for conveying all sorts of waste *water* (save those connected with privy). It should be *situated* – at one or more sides of the building ; be *built* of cement on concrete ; should have an even, regular *fall* towards the drain *and terminate* in drain.

2. THE CLOSET.

What it is: It is an isolated sanitary receptacle, installed in private, for the *reception* of excreta into itself and for *transmission* of the same into the drains of the Sewage System.

Number.—The number of water closets to be provided is—1 seat for every 15 to 20 persons. In the case of mills, factories etc., 15 seats per 1000 population is desirable, though the Factory Act allows 1 seat for 50 men,—in which case, separate urinals must be provided.

Parts of water closet are: (1) A pan or basin, (2) trap, (3) flushing cistern and pipes and (4) arrangement of soil pipes.

Privy.—The place in which water closet is situated is called a *privy* or a *private* place of ease; where several water closets are installed alongside each other and are meant for *public* use, such a place is called a *latrine*. A privy should be *situated* against an outer wall, detached from the main building and be open on at least two sides for cross *ventilation*. It can be built upon, only for a similar purpose. It must be *brick-built*, its *floor* should be two feet higher than the general ground level. Its *walls* must be cemented or paved with glazed tile upto six feet from floor, which, also, should be similarly cemented or paved. In *European* houses, where the water closet is so fixed that its trap forms a pedestal on which the basin rests, the floor should slope towards the door; in *Indian* houses, where the water closet is sunk in floor, the slope is to be into the pan.

Latrines—should be well *screened*, brick *built*, be on higher *level* than ground, cemented or paved with glazed tile on the *inner walls* all round upto a height of 4 feet from floor as well on the *floor*; their *outside* should also be paved for a distance of six feet all round. The *slope to the closet* should be ½″ to 1″.

[In fixing water closets in the upper storeys of houses, a lead tray (called a "Safe") *used* to be placed beneath the closet—the "safe" having a waste or overflow pipe leading to open air; this prevented the overflow from closet (on account of leakage) from soaking into the floor. With modern closets, this "safe" is unnecessary.]

Essentials of a good closet are: (1) It should be of *non-absorbent* and non-corrosive material. (2) It should be of proper *shape* and *capacity*, so that (3) excreta should not touch its sides but *drop* directly into its proper place. (4) *Flushing* arrangement should be such as to completely scour the basin and remove all excreta at one flush. (5) It should have an efficient *trap* immediately under its basin. (6) Its *joints* should be gas and water-tight.

Classification of closets:—(A). The Pan, the Valve, the Wash-down and the Wash-out closets (B). (1) *Flushing* closets which require cistern water to sweep out the dejecta; (2) *Waste water* closets—in which slop water sweeps out the dejecta; and (3) Closets that receive *liquids only*—as urinals, sinks etc.

(A) Closets for special purposes.

I. Waste-water or Slop Closet: In the other two classes, the excreta that fall into the pan or trough are swept out of them into the drains by means of cistern or tank flushing arrangement. But this system seeks to flush by means of the *house* waste water only.

Its Advantages:

1. Initial cost—is small
2. Consumes less water
3. Produces less sewage
4. Does not freeze or get out of order easily.
5. Suited for outdoor purposes.
6. Does not require separate flushing arrangement

Disadvantages.

1. Unsightly.
2. Less cleanly, because of fouling and lodgment of excreta on sides.
3. Requires: (*a*) good fall in the sewers; (*b*) public service of water in each house; (*c*) separate closet for each house.

CLASSIFICATION AND VARIETIES:

(*a*) FOWLER'S DIRECT DISCHARGE CLOSET—in which the slopwater runs directly into the basin or is poured down into it by hand. [Its *disadvantages* are: (*a*) The force of stream of water is often insufficient to flush it well; (*b*) back and sides get fouled; and (*c*) improper substances may get in and choke it.]

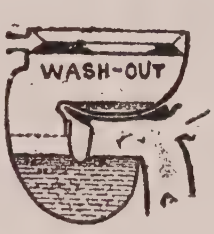
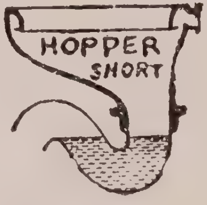
(*b*) HILL'S SYPHON CISTERN OR TIPPER DISCHARGE—in which the slop waste collects in one of these and is automatically suddenly discharged. For single closets, 3 gallons and for two or more closets in a row, 5 gallons should be discharged each time. These are called *top* or *bottom flushing*, according as the tipper is placed close to sink or well away from slop stone.

II. Urinals—should be *situated* away from and on the leeward side of buildings, on slightly elevated cemented *platforms*. There should be arrangement for regular, automatic and copious *flushings*, the discharge of water taking place at the channel or slope in the floor; the *channel* or *receptacle* of urine and the *walls* of the place should be made of slate, enamelled slate, white enamelled fire clay, glazed stone or earthen ware or enamelled cast iron; there should be no corners. The *floor* should be trapped at its lower end. Urinals are constructed either as (1) STALLS or (2) with TROUGHS—in which water is retained by a weir, or (3) with BASINS (with flushing rim.)

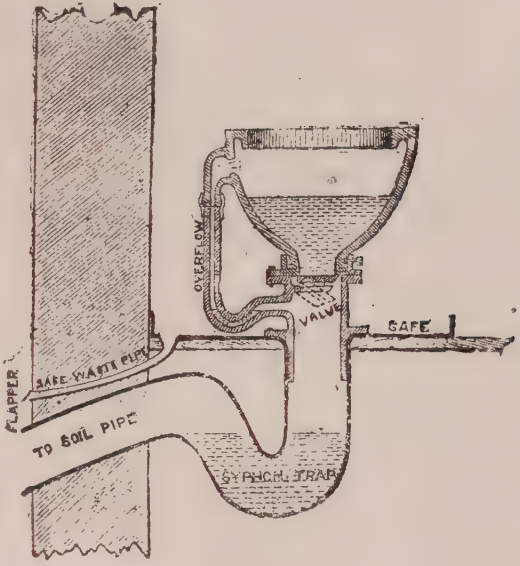
III. Slop-Sinks—should be on the short hopper style, provided with a grid to catch larger foreign bodies, with rim flushing and a syphon trap.

In Indian house-holds, where separate bath rooms do not exist, separate pipe-arrangements for slops and baths do not exist. All pipes—rain water pipes, urinal sink pipes, waste water pipes—end over the yard gully, whence the water is conveyed to public sewer viâ traps.

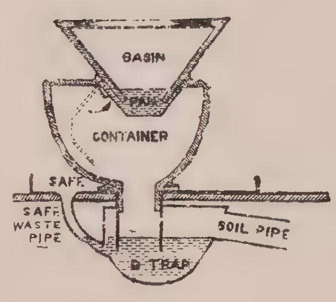
(B) Water Closets in Private Installation.

Name	*Material of which made*	*Shape &c.*	*Relation of Basin to Syphon*	*Trap (shape of)*	*Cistern flushing through*	*Advantages*	*Disadvantages*	*Remarks*
Long Hopper (Wash Down)	Stone	Inverted cone 18″ long and narrow	Basin forms part of syphon	**P** or **S**	A side opening	Nil	(1) Basin is fouled (2) Insufficiently flushed by 2 gallons	(*Old type*) Bad
Short Hopper or Wash Down	Stone or Fireclay	Conical 8″ to 9″ long but back is vertical	Do	**S**  	Rim	(1) Simple construction (2) Not expensive (3) No fouling of side (4) No overflow pipe is required.	 	Good (Best for outdoor) (*Modern*)
Wash Out	Stone or China	(Modification of Long Hopper)	Basin does *not* form part of syphon	**S**	Rim	Basin retains water	(1) Cannot be flushed with 2 gallons of water. (2) ∴ Basin becomes soiled near outlet	Good (*Modern*)
Dececo Syphonic	—	—	Basin forms part of Syphon	**S**	—	Contents are both forced out and sucked out	(1) Foul water returns to basin after flushing; ∴, (2) Air-escape pipes are required	Not good (*Old type*)

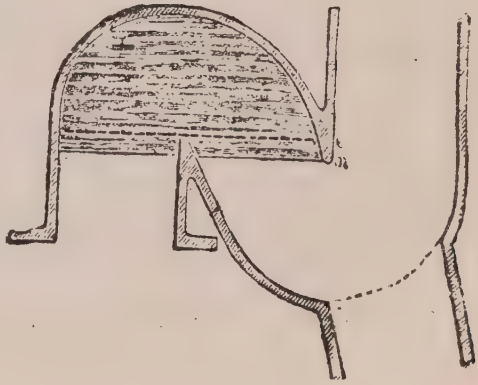
Pan or Container	China Basin + metallic pan	Conical with a tray like pan	Trap forms nether end of basin	Anti- **D**	Rim	—	(1) Allows foul air in. (2) Metal wears away. (3) Soils itself. (4) Some excreta always remain in trap	Dangerous (*Old type*)
Plug or Valve	China or stone	Hemi-spherical	Basin does not so form	Ditto or **S**	Rim	(1) Outlet of basin has water-tight clack valve. (2) Noiseless.	(1) 6-8 gallons required to flush. (2) Overflow pipe required. (3) Valves leak, ∴ (4) Foul air gets in. (5) Water not retained	Good (*Old type*)



VALVE CLOSET.



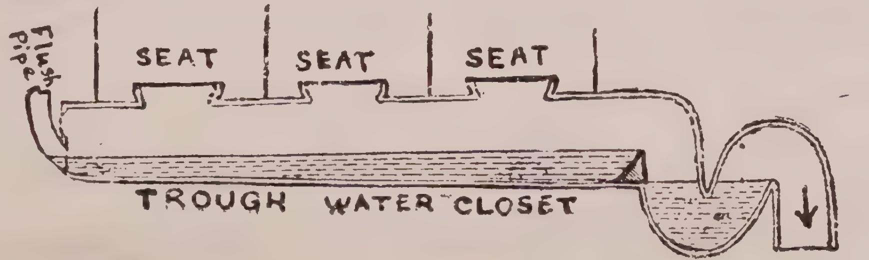
PAN CLOSET.

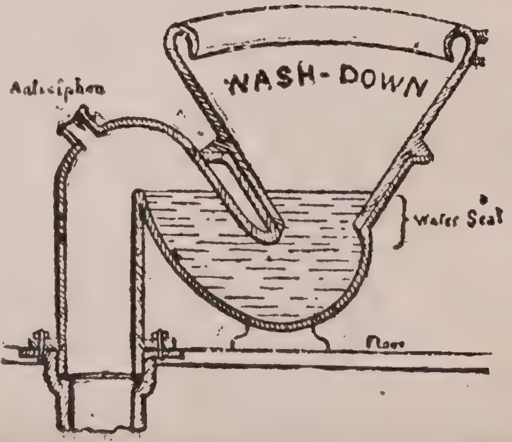


VENTILATED SYPHON TRAP.

(B) Flushing Closets for Public Installation (School &c.)

Types	*Basin*	*Water Trap*	*Material of which made*	*Points about Trough*	*Flushing*	*Remarks*
Old **Pattern**	None separate: trough forms common basin	Scanty—formed by inverted D channelled pipe, open to the sky	Trough-of stone ware	Open half pipes in gradient. Protected at end by weir and grid. Terminates in low syphon trap	By Fields' annular syphon flushing tank	Unhygienic (cheap, can never get out of order)
New **Pattern**	Each seat has a Basin which opens into trough.	Good high syphon at outlet of trough, which is a complete tube	Closet of glazed china; and trough (trap) of iron	It is a closed tube with a high syphon trap; latter provided with access hole	By automatic flush, through rim in each basin	Better
(*Separate*) **Pedestal wash-down closet**	See ante, under "wash-down" closet.					Best





3. TRAP.

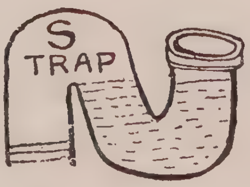
Definition : It is a barrier, to prevent influx of sewer-air into the premises. This is effected by the **water seal,** which means, the vertical distance between the level of water and the lowest point of the bend of the upper surface of the trap. [Manhole and other disconnecting devices serve other purposes than as simple foul gas-barriers.]

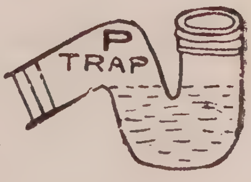
Essentials of a good Trap are : (1) Water seal should never be below $\frac{3}{4}''$ above the openings. (2) It should be of such *form* as to be capable of complete *flushing* with water. (3) It should completely *disconnect* the air of one pipe from that of another. (4) It should not have any angles or projections and be *watertight.*

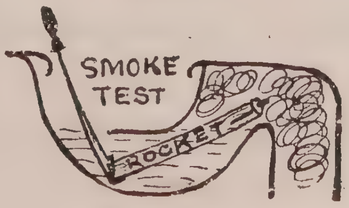
Position : A trap is placed in these positions :—(1) Beneath the *pan* or basin of a closet. (2) At the junction of *house drain* with sewer. (3) At the point of entrance of *slop and rain water gully* in the yard of a house (=gully or grease trap).

Varieties. To prevent influx of sewer air, a large variety of traps have from time to time been constructed. They are as follow.

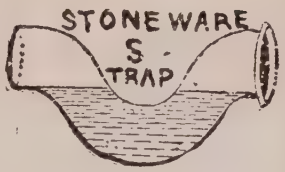
1. **Syphon**—*Advantage :* The most cleanly and cleanable. *In form*, it is a bent tube, the bend being full of water upto at least $\frac{3}{4}''$ above top of curve. *If two syphon traps have to succeed each other*, an air opening should be placed between them, to prevent syphonage.



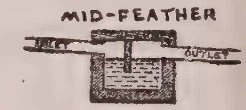




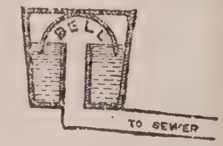
Disconnection can also be effected by—"Sewer air trap"—which is an ordinary syphon trap, of a size smaller than that of the drain, with a seal of 2″—3″ of water, having a fall of 2″ or more from the level of the discharging end of the house-drain to the surface of the trapping water; and provided with a fresh air inlet pipe.



2. **Midfeather**—*Disadvantages* : It is not self cleaning and may leak gas under its covering-stone and cannot be easily cleaned and gets deposits. *It is* a round or square box with a movable stone lid, from which hangs an incomplete partition just dipping into the water. The box has an inlet and an outlet tubes at the same level, below the lid—the level of water, being the lower margin of these 2 level tubes. The cover is rarely air-tight.



3. **Bell**—is a modification of midfeather trap, the water seal being broken on removing the bell, which is removable. *Disadvantages* : In it the water-seal is too shallow ($\frac{3}{8}$ inch) and therefore gets easily evaporated, choked and broken ; and when the grating is removed, the waste pipe is untrapped.



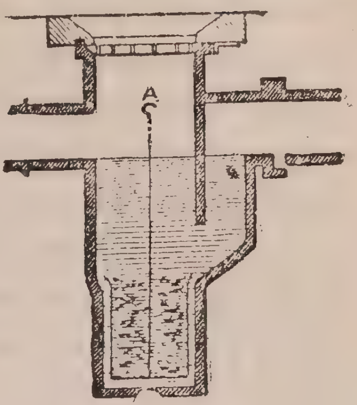
4. **Flap**—In it, a hinged valve allows water to flow in one direction only. *Disadvantage :* It does not prevent sewer air returning into the premises.

5. **Ball**.—A ball rises with the rise of water and closes an orifice. *Disadvantage :* This is imperfect.

6. **Gully Trap**. *Dean's* variety is the best. *It is intended* to receive rain and soil water and has a small superficial

surface. It has a movable bucket at its bottom, to remov solid particles likely to choke the drains. This trap should be placed at least 18″ from the walls of a house.

7. **Grease Trap** is a variety of gully trap. This is provided with a grating and a flush tank and is made of stone ware. The waste pipe, before it discharges into the grease trap, is syphon-trapped under the sink.

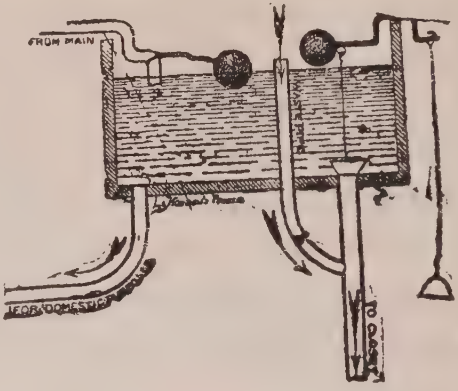


Dangers of Traps: (1) A trap is *not absolutely* gas-proof: for, the bad gas of a sewer may be dissolved by the water in the trap and disengaged into the premises. (2) *In dry weather*, the water may evaporate, thereby establishing direct communication between sewer-air and atmospheric air inside the house. (3) A trap may become *untrapped owing to syphonage—i.e.* with one act of flushing, the whole water in the trap may be sucked into the sewer pipes. Hence, to prevent 'syphonage', **antisyphonage pipes** are required communicating from beyond the trap to the outer air.

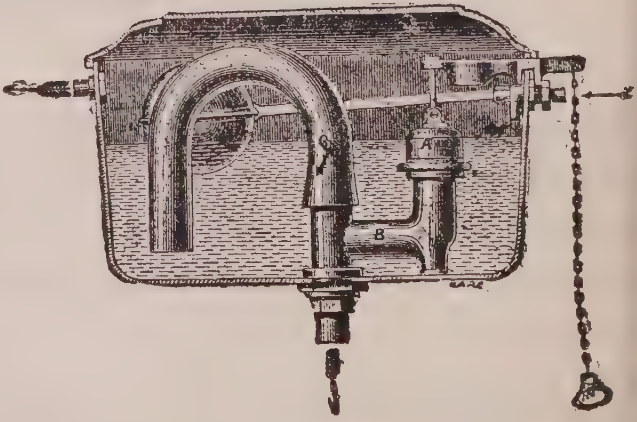
4. FLUSHING ARRANGEMENTS.

Object.—The water-carriage system requires the *sudden* discharge of a quantity of water to effect removal of the more solid dejecta. This is necessary in every form of closet (except the waste water or slop closet) and in case of the separate sewerage system, where, for storm water, there is a separate piping arrangement.

The hygienic essentials of flushing cisterns are:—(1) They should have a *supply of unfiltered water*. If, however, filtered water connexion exists, the supply pipe should have a draw-off tap, from which drinking water can be drawn before it enters the cistern. There should be no connexion directly between the drinking water cistern and the closet pan. (2) Cistern should be *made of* galvanized iron, zinc or slate. (3) *Situated*—on roof of house; or, 4 to 8 ft. above the ground level, the diameter of the discharging pipe being $1\frac{1}{4}$ to $1\frac{1}{2}$ inch.; or, at the seat-level, in which case, the outlet pipe should be large, but narrowed just before the pipe joins the pan. (4) For each closet, a separate *pipe* should issue from the tank. (5) *Amount of water discharged* at each flush should be—3 gallons. (6) *Filling*.—The cistern should fill upto 2″ below the level of waste pipe; it should not fill in, while it is discharging; the tap should not be submerged when the cistern is full. (7) *Overflow* or waste pipe must be always provided; this is to discharge at a prominent place, never into a drain. *Maintenance*.—Cisterns should be kept water-tight and covered, to prevent access of flies, rats, mosquitoes etc. (9) *Cleaning and inspection* should be done through a manhole. (10) *Flushing* should be effected after each use of the closet [The "Pull and let go" or syphon-action cistern



INSANITARY CISTERN.



is to be preferred, as it ensures a thorough flush with even a short pull.

For Flushing house drains with insufficient gradient, automatic flush tanks fed with clean water should discharge into a gully at the head of the drain.

5. DRAINS.

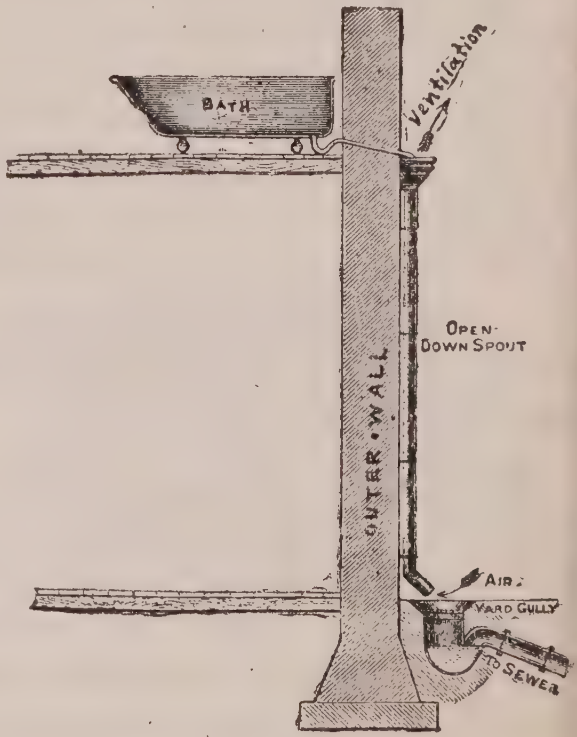
Definition :—A 'drain' (as opposed to a sewer) is a conduit, conducting the sullage and soil waters of the drain of one building or premises in one occupation, leading into a sewer or cess pool. [A *drain* in common parlance is a yard gully; scientifically speaking, a drain is a close conduit pipe; a gully is an open gutter.] The drainage of a premises on the water-carriage system is divided into two sets;—(1) Waste-water drainage by *Waste* water Pipes. (2) General effluent drainage by *Soil* Pipes.

They begin where yard gullies, or water-closet pipes end, usually, without the walls of the premises. Yard gullies carrying all sorts of waste waters, end in a silt chamber (24″ × 7″), a vertical cast-iron grating interposing between. It is from the silt chamber (in case of yard gully) or the trap (beyond the water closet) that drain begins and at the very starting of drains, inspection *manholes* are fixed. Drains **end** in public sewers.

I. **Waste-Pipe-Drainage**—Waste water includes water from baths, lavatories, sinks, safe trays under closets, rain water and surface water.

Their hygienic Essentials are: (*a*) Every bath, lavatory or kitchen sink should have a syphon TRAP fixed to it. No waste pipe (except that of slop sink) should be CONNECTED with a soil pipe or a gully. The *main* waste pipe should end in its upper part above the roof eaves, and in its lower part, in the open, 18″ above the grid covering the trap of the gully. (*c*) In case of kitchens, a grease gully should be utilized. (*d*) The waste pipes *from baths*, *lavatories* etc. should be as short as possible and of 1½″ to 2″ diameter. (*e*) A waste pipe may DISCHARGE INTO the open head of separate rain water pipe, (where such exists already), the rain water pipe proper being cut up into various lengths, if necessary, for the reception of pipes at different levels, provided, such rain water pipes are not near windows. (*f*) Waste water pipe should be MADE OF lead 3″ in diameter. (*g*) To prevent syphonage, ANTISYPHONAGE PIPES should be fixed to each waste pipe.

II. Drainage by Soil Pipe.—The effluent from water closets *of different storeys* is carried by soil pipes. The soil pipes are *made of* either drawn, milled or rolled lead (never seamed lead) or cast-iron (coated with Angus Smith's varnish), and are of uniform thickness and of 3 to 4 inches diameter. They are *fixed to* the outer wall and should not be made to pass under the premises. They *begin* full bore from above the roof-eaves of the top floor (being there protected by cowls or wire-cage) and *end* by discharging (in the case of sewered towns) into the sewer pipes, *interposed*, first, by an inlet ventilating hole and then by a trap; but in no case should it end abruptly into a trap. [In non-sewered towns, it can pass into a cess-pool, a ditch, pond or stream or into the soil]. It should also act as a



Ventilator of all the closets,—directly, only of the topmost closet, and indirectly, of all the others, through the intermediation of *'antisyphon' pipes*. Each of the latter opens, on the one hand, into the closet beyond the trap and on the other, into a common vertical antisyphon pipe—(the common antisyphon pipe being the upward continuation of the lowermost single antisyphon pipe) and terminating in the upper part of the soil pipe, above the place where the latter is joined by the exit pipe of the highest closet. Soil pipe can *communicate only with* that waste-pipe which receives urine or foeces—never with rain-water, bath or slop-sink waste-pipes.

Points of view: A drain has to be studied from the following points of view : (*a*) *Material* of which it is made : (*b*) *bed* in which it is laid ; (*c*) its *fall* ; (*d*) its jointing ; (*e*) its construction ; and (*f*) its inspectional facilities.

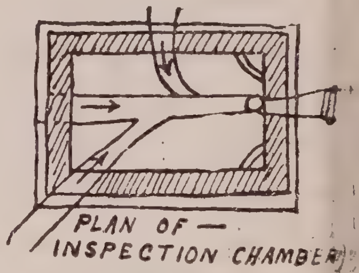
(1) **Material**—Pipes should be *made of* stoneware or iron, in *lengths* of 2 ft. each section, and of such round *calibre* as to be able at all times to carry off the maximum rainfall, without ever getting blocked. Usually, the smaller the calibre, the more thorough is the flushing ; hence, for small houses, it should be 4 inches, for large houses, 6 inches and for larger institutions, 9 inches. [**Where much hot water is discharged,** the pipes shall be of cast or galvanized iron, rather than of lead. Stoneware, zinc or wrought iron ("Durham system") are never to be used, as their jointing is seldom faultless].

(2) **Bed**—should be as much as possible, in a straight line, smooth, inclined and on hard ground—or 6″ of cement concrete, where the pipe passes under basement of a house. The fixing of the pipes should be in all cases absolutely rigid.

(3) **The fall**—should be 1 : 40 for 4″, 1 : 60 for 6″ and 1 : 90 for 9″ pipes.

(4) **Jointing.**† The socket-end should point towards the head (or commencement) of the drain and cemented with *Portland cement* joints and not puddled with clay. [*Stanford's* or *Doulton's* patent joints are inferior to cement, liable to erosion and soon become devoid of water-tightness] Care should be taken that cement does not get inside pipes, forming projections to obstruct flow of sewage. Where a small bore pipe has to be jointed to a large pipe, a tapering pipe should be interposed between them. Doulton's patent ceramic joint is the best for connecting closet basin and pipes.

(5) **Construction** : (*a*) *At bend*—there should be curved pipes, the radius of a curve being at least ten times the cross-sectional diameter of the drain. (*b*) *At branchings*—V-junction pipes should be fixed, so that the branch current may flow nearly in the direction of the main current. (*c*) *At every change of direction*—Manhole-inspection-chambers should be provided, the drain being continued through the floor of the chamber by ¾ curved channel pipes. Into this chamber, the branch drains should discharge by short curved channel pipes. (*d*) *Where the drain pipe leaves the premises*, the wall should have relieving arches and inspecting manholes at each end.



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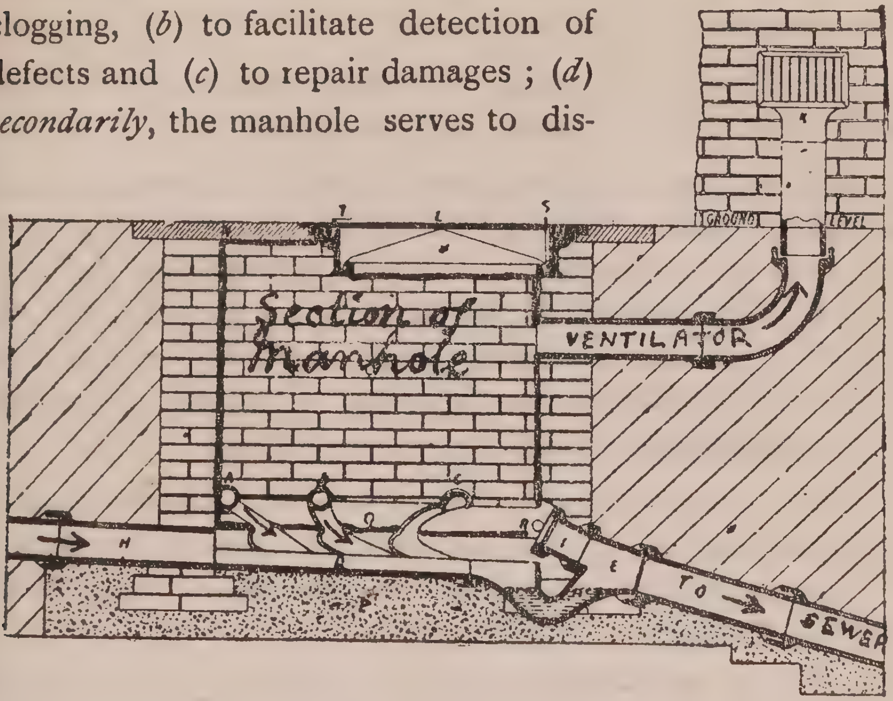
† In joining pipes, (*a*) if both are of cast iron, make a simple caulked lead joint ; (*b*) if both be of lead, a wiped, solder or plumbers' joint is used ; (*c*) if one is of earthenware and the other of iron—use metallo-keramic joint or clamps and India rubber.

(6) **Inspectional facilities** :—This is afforded by the **Manhole** chamber. *Situated*—in yards or open areas. The OBJECTS of manhole *primarily* are: (*a*) to prevent clogging, (*b*) to facilitate detection of defects and (*c*) to repair damages; (*d*) *secondarily*, the manhole serves to disconnect the house drain from the public sewers. Although sewer air is not more harmful than ordinary drain air, constant inhalation of it causes rapid and profound constitutional disturbances, and out-breaks of infectious diseases. In the absence of manhole chamber, during course of repair of faulty house drains, sewer air may find access into houses. Hence the necessity for it. It COMPRISES—(i) The *main drain*—in the form of glazed channel pipe, from which the floor slopes up at an angle of 30° towards the walls. It discharges into the trap. (ii) *Branch pipes*—½ to ¾ curved channel pipes, which discharge over the main drain. (iii) *Spyhon trap*, provided with a raking arm or clearing eye. (iv) Ventilation or *Fresh air inlet* pipe—communicating between the interior of the manhole, opposite the entrance of the drain and the outside air. Its CONSTRUCTION :—



Walls—are made of brick work rendered in cement. *Floor*—made of cement concrete. It is *Roofed above*—with air-tight iron cover; or, with double-seal condensing cover, if manhole is built inside the walls of a honse.

To Test Drains, Soil Pipes and their Branches as to their integrity.—Usually, five means may be adopted :—

(i) HYDRAULIC or WATER TEST—*applicable to* new drains laid and jointed, but before they are embedded in concrete. *Draw back*: This test cannot be applied to old drains withont injuring them. *Procedure*: The lower end of the drain, at its entrance into the disconnecting chamber, is plugged firmly and from the upper end, water is poured in (allowing imprisoned air to escape); if the water level is maintained undiminished, the drain is sound.

(ii) BALL TEST—Its *object* is to ascertain that there are no projections of cement from the joints into the interior of the drain—a spherical ball ¼″ less in diameter than the drain being passed into the new drain, before it is covered in.

(iii) SMOKE TEST—more *applicable to* vertical soil pipes and ventilating pipes than to under-ground drains. The smoke is discharged into pipes by means of smoke rockets or smoke machines, watch being kept for leakages. See figure, p. 240.

(iv) PNEUMATIC OR AIR TEST.—This is a severely straining test but fails to reveal the seat of defect.

(v) CHEMICAL TEST.—By means of Kemp's apparatus, a mixture of phosphorus and asafoetida is thrown into the pipe and the spot, whence the white fumes and smell come out, is the defective spot.

To repair leaky drains in situ: Claose the drain; Portland cement under pressure is then forced several times into the drain; then a swab is drawn through.

Special circumstances of Drainage.

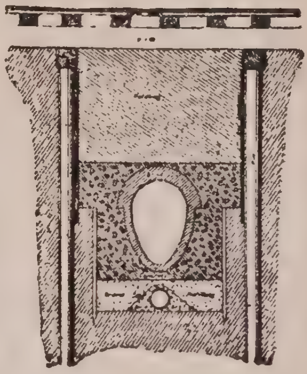
(I) MINES: Besides dangers of accidents and pulmonary diseases, the spread of *enteric*, *cholera*, *ankylostomiasis* &c. is common in mines. To prevent the spread of these, through food and drink, these precautions should be taken :—(1) All *new admissions* should be thoroughly examined for enteric and ankylostoma infection and if found harbouring any, should be excluded. (2) All *cases of illness* must be reported and enquired into. (3) Miners should be encouraged to *defoecate* morning and evening—*i.e.*, off working hours and therefore not inside the mines. (4) *Privies* and *water closets* should be provided at pit mouths, where *spray baths* and dressing rooms should also be provided. (5) They should never *drink* mine water ; and collection of stagnant water in the workings should be discouraged. (6) All *edibles* should be *kept* covered in tin or papers and handled through paper, the hands never touching the mouth. If possible, food should be eaten after a complete change of clothes and wash.

II. STABLES. *The floor*—should be of adamantine clinker with chamfered edges set in cement, at a *gentle slope* of 1″ in 10′. The slope should fall towards the *Channel*—which must be set in cement and iron-grated, to catch solid particles. This channel leads into *the Gully*—which should be a Dean's slit gulley with removable bucket for collecting solid particles. *The litter* being made of straw or of dried peat moss, should, along with manure, be discharged directly into carts or vans so as to minimise their disturbance. In the alternative, the manure should be kept in open wire cage resting on cemented surface—never into dung pits.

CHAPTER XVIII.

SEWERS.

Definition.—Sewers are underground *public* channels which receive the drains of more than one house and *automatically* carry away (by gravitation) rain water, surface water, sullage and excreta, thereby effecting **two purposes** (if made of bricks) viz., (1) removal of sewage and (*b*) drainage of subsoil water.



Two systems of sewers are known, the separate and the combined. The **separate** system comprises one set of drains which carries away *rain* and *surface water* into the nearest stream and quite another set, which carries away *excreta* and *sullage* water to be returned to the soil. Subsoil water is drained by agricultural-tile-drains laid above the sewers in the same trench with surface and rain water trenches and discharging into nearest water courses. Sewers were originally rectangular channels intended to carry off rain and surface waters only. First, house drains and then, water closets began to be connected to them, thus producing the **Combined** system, which carries away, in the same channel, street as well as house refuse and waste water. **Advantages of the separate system** : (1) The volume of sewage is usually small and can therefore be calculated; hence, construction is more perfect. (2) Composition of sewage is uniform ; it can therefore be utilized better. (3) Sewers are better flushed, because fuller ; hence, there is less fouling and deposit. **Disadvantages** : (1) More expensive, because of two sets of pipes having to be laid down. (2) After drought, water may be too voluminious ; therefore, scavenging has to be efficient. (3) During drought, flushing is insufficient and when dry, much fouling occurs. [In the combined system, maximum scouring effect and velocity are obtained with minimum water.]

[The Calcutta sewer is a combined sewer. Its faults are :— (*a*) Liability to sudden overflow after a heavy downpour of rain. (*b*) It has 4 outfalls into the Hughli and one into the salt lakes ; during flood tide in the former, all sewers become inoperative. (*c*) Necessity for pumping and handcleaning, owing to insufficient gradient, the town being a dead flat level. (*d*) Sinking of portions of sewers, which are brick built, and increase of epizootic diseases in Calcutta]

Essentials of a good Sewer :—It must be *self-cleaning,* having sufficient water supply per head to carry off sewage and silt, automatically, 3 ft per second ; or else, stagnation and consequent concentration of sewer gas and choking result. (*b*) Its *construction* should be faultless ; or else, it leaks, cracks, sinks, or is rendered useless by rats and roots of trees, thereby poisoning nearest water-supply. (*c*) It should be properly *ventilated* or else it may unseal traps and pollute the air of houses. (*d*) The *outfall* should be sufficiently low or else, during flood tide, the whole sewage may be forced back into cellars of houses. (*e*) The sewage should be suitably *disposed of ;* or else, it will create nuisance.

Constructional details :—*It begins* where house drains end and *ends* either into the nearest water course or upon a waste land. It should be *constructed of* brickwork, concrete, silicated stone or iron and be air and water tight. It should be *laid in* trenches, sufficiently deep (at least 5 feet) to drain house basements, to resist frost and to be unaffected by heavy traffic and be as *straight* as possible right up to the outfall. Its *gradient* must be uniform and between 1 in 250 to 1 in 5000,—small sewers requiring greater incline than large ones. Sewers having less than 24″ diameters, should have a *flow* of 2½ ft. per second ; and those over 24″ diameter, 2 ft. per second. Where the gradient is insufficient, use the pneumatic system of pumping up the sewage (See p. 255). Where differences of level exist, **intercepting sewers*** are constructed to carry off the drainage at different levels ; or, a series of steps are constructed to guide the sewage from a higher to a lower level. Sewers must have their *diameters* equal to the utmost volume of sewage that can be produced ; sewers that run nearly full are better flushed than those that run less full. No public sewer should be less than 9 inches in diameter. Note that—

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* These run *along* instead of *into* water courses and help to divert the crude sewage far away into the lowermost water level.

If diameter of sewer is	*Its fall per mile is*	∴ *Velocity of sewage carried is*	*Velocity of flow is*
10 ft	2 ft	100 times	same in all cases.
5 ft	4 ft	25 „	
2 ft	10 ft	4 „	
1 ft	20 ft	1 time	

The interior of all sewers must be very smooth, with no projections and be well *ventilated* and throughly *flushed.* All *junctions* must be made at an acute angle, tributary sewers opening in the direction of the sewage flow, and all curves having a radius of not less than ten times the diameters of the sewer. *The shape,* in case of brick-made sewers, should be circular, when the flow is large, and oval, when the flow is irregular in quantity ; in the latter case, the maximum transverse diameter $=\frac{2}{3}$rd of the vertical diameter.

The Outfall—should be unobstructed and extensive. (*a*) *If it is into the sea or tidal river*—it must be below the low-water mark, irrespective of tides and guarded by a flap which prevents entrance of water. [A similar flap should be provided, when it is not below water, to keep back regurgitation of wind]. (*b*) *When sewage is tide-locked* for certain hours,—it should be led into tanks, so as to prevent blocking inside, and discharged at leisure from these tanks into the streams. (*c*) *If it has to be carried across* a river or valley,—do so by bridges. (*d*) But, where such carriage is necessary, and, at the same time, the outfall lies on a low level, carry the sewer across by means of an inverted syphon laid in the valley or bed of the river. The sewage may have to be stained and flushed occasionally when the velocity of the current is not sufficient.

Inspection of Sewers—is necessary for *purposes* of examination, cleaning and removal of accumulated deposits. It is effected by means of brickwork '**Manhole**' shafts. (p. 247).

Flushing is *required for* sewers that have (1) bad *construction* or (2) *sunk* in their beds or (3) have sharp *curves* in their interior or (4) have insufficient *gradients* or (6) have insufficient *liquid*, as in hot dry weathers (in the case of separate system.)

It is effected—(1) In case of PIPE sewers or upper ends of BRICK sewers,—by *automatically*-discharging flush tanks (Field's), or tidal valves or pivoted gates. (2) In other cases, over sectional areas,—by damming back the sewage and then allowing a sudden rush, as by means of self-acting or *hand*-worked flushing gates.

Use of hot water—for flushing leads to (*a*) enhanced *putrefaction* and (*b*) regurgitation of sewer *gases* into houses; hence, it should be avoided.

Ventilation of sewers is **necessary**, (*a*) because sewer air is concentrated, poisonous, *germ-laden*, and therefore a source of disease; (*b*) because it has an evil *smell*; (*c*) because, otherwise, foul gases from sewer, will find an exit only *into interior of houses*, through house drains and traps; and (*c*) because, otherwise sewer air is likely to be set *on fire* by sewer-men getting in with naked fire. **It is called for** in sewers in which deposit forms, *e.g.*, in flat-bottomed brick conduits, sunk-in oval sewers, too capacious sewers, outfall sewers, in which the sewage is backed up for certain hours in the day. In them, the sewage putrefies quickly, producing gases. [Pipe-sewers being smooth and often running full, deposit less on their sides than do brick-sewers.]

Effect of sewer gas on health—See Author's Medical Jurisprudence, 4th Ed. [Sewer **air** is harmless, odourless but sewer **gas**, the result of stagnation, deposit and putrefaction, contains double amount of CO_2 and treble amount of organic matter and less number of microorganisms than outside atmosphere].

Ventilation is effected—I. Naturally, by (*a*) quick *velocity* of the sewage, where that exists ; (*b*) difference of *temperature* of air inside and outside the sewer,—in winter, the inside-temperature being 7° F higher, in summer days, cooler ; (*c*) constant *saturation* (and ∴ lightness) of sewer-air ; (*d*) discharge into sewer of *hot fluids* from boilers &c. causing expansion of sewer air ; (*e*) inrush of excessive *storm water* or rapid rising in volume of sewage in the morning hours—causing rapid expulsion of inside air ; (*f*) sudden *barometric* or thermic variations in the outside atmosphere. [Sewers laid with deep gradients act as chimney for the sewer air, which tends to run back to the town !]

(2) **Artificially,** ventilation of sewers is secured by means of—: Shafts—which should be erected at three places—(*a*) at the highest point of the sewage system, (*d*) at the point of its discharge, and (*c*) at several intermediate places, not more than 100 yards apart. Shafts may be of 3 *varieties :* (*a*) Shafts reaching to street-surface and provided with locked iron top-covers ; these are undesirable ; (*b*) Shafts of iron carried well above the house tops—suitable for narrow courts and streets ; and (*c*) Shafts sunk by the side of, and laterally connected with, manholes. [Manholes are best situated at all important junctions, angles and changes of gradient]. These shafts commence from crown of sewers and (*a*) and (*c*) should be provided with removable dirt-box at their openings into the road surface. For shafts to be safe and convenient, street

gullies should be effectively trapped. But where sewers are ill-ventilated, to trap street gullies spells the sucking in of sewer gas into houses !

[(*a*) Ventilating the sewers by means of *soil-pipe-ventilators of houses*—is harmful ; because, in that case, disconnecting traps of, and fresh-air inlets to, house drains cannot be fixed. (*b*) Ventilating the sewers by means of 4″ pipe carried *from the sewer-side of trap of house* drain—renders its purpose nugatory when it is most required *viz.*, during heavy shower, when the opening into the sewer may be sealed by the height at which the sewage is flowing in the sewer.] (*c*) Some of these shafts act as inlets others as outlets for the sewer gas.

To purify the air of sewers.—(*a*) *Charcoal* boxes—if placed at the sides of ventilating gratings or in manholes, are but poor deodorizers—for charcoal absorbs 8 times its bulk of CO_2 and oxidises the organic matter into nitrites and nitrates. They require frequent changing, because they get clogged with dust. Similarly, *potash permanganate* (Reeve's process) has been used. (*b*) *Cremating* the sewer gas by passing it over a gas flame placed in a chamber at the top of a ventilator or at bottom of street lamps placed over these shafts. This sterilizes the sewer gas and creates an upward draught for the sewer gas. (*c*) *Connecting the sewer gas with a furnace chimney*,—in order to shoot it out of the range of the tallest buildings. But the draught created by this is so strong for so short an area, that all the traps run the risk of being unsealed. "Any attempt to drive the air along in a sewer (plenum system) will force the traps of houses, while attempts to exhaust it (vacuum system) only affect a short length of the sewer."

Pneumatic System of sewage carriage.—This is a modification of the water-carriage system and **it seeks** to collect night soil and slop water direct from the water closet. Ordinarily, on the water carriage system, every sewer is so constructed that it carries its own sewage automatically by sheer force of gravitation. But, where the tract of the country is *a dead flat one*, the sewage has to be carried by *non*-gravitation methods to or towards the outfall. Such non-gravitation methods are either (*a*) by *suction* action (Liernur or Berlier system) or (*b*) *forced* by compressed air (Shone system).

Liernur's Suction System : Two sets of pipes are necessary—one carrying waste water from houses and factories into the nearest water course and the other carrying excreta and bed room slops. Both are led to small *reservoirs along the street*, which communicate with a *central* reservoir at the sewage works. A vacuum created at the central reservoir sucks in the contents of all street-reservoirs ; from this place, the sewer is pumped out and manufactured into poudrette.

Berlier Suction System—resembles in principle Liernur's, but (*a*) it receives the contents of the soil pipe into a receiver, where they are strained ; then (*b*) the strained filtrate is automatically sucked into the evacuator.

Shone Ejection System—Cylindrical underground chambers receive the contents of the sewer. When they become full, the compressed air ejectors, situated in those cylindrical chambers, are put into action, whereby the sewage is conveyed up to the outfall or into a 'sealed' sewer of cast-iron, whence they receive natural gradient.

Advantages of pneumatic System over water carriage System—(1) Sewers and house drains are air-tight ; hence no *leakage* of gas occurs. (2) *Gradient* is no question in its laying down. (3) No *water* is required. (4) The removal of sewage is very *prompt*. (5) The sewage can be manufactured into *poudrette*. (6) No *special fittings* of any kind are required in the house.

Advantages & Disadvantages of the two forms :

Forced (Shone)	Sucked (Liernur)
1. No storage of sewage is required.	1. Temporary storage of sewage is required.
2. No separate disposal necessary for slop water.	2. Such is necessary.
3. Pipes have little risk of clogging with foeces.	3. Great such risk exists.
4. Drain traps do not get unsealed.	4. They do.
5. Works automatically ; the motor (compressed air) can be divided among any number of stations without loss.	5. Does not work efficiently.

CHAPTER XIX.

PURIFICATION and DISPOSAL OF SEWAGE.

Introduction.—At the outset, it is important to remember certain outstanding facts :—

(*a*) **Purification** means rendering the *effluent* of sewage free from *organic* impurities and *bacteria*—and therefore rendering it inodourous and non-putrescible, though dirty to look at. But it is important to remember that, no process of purification renders the effluent *absolutely* microorganism-free. **Clarification**—is simply *precipitating* its *particulate* matters, without reducing the putrescible organic matters or bacteria.

(*b*) **Formerly**, *i.e.*, before the discovery and use of the biological processes, *clarification* was looked upon as purification ; and, in clarified sewage, one had to dispose of separately two things—(i) the **sludge** or particulate organic impurity that settled at the bottom, consisting chiefly of minerals and organic matter ; and (ii) the **effluent**, which was the innocuous liquid left over after the sewage was clarified. *Now-a-days, real purification* is effected, whereby sludge is reduced to a minimum and is practically out of count ; and effluent is easily got rid of, or sold as manure.

(*c*) The *older* **methods** of sewage **disposal** were, in chronological order—(i) Cesspool system, with or without trenching ; (ii) Discharge into river or sea, with or without preliminary clarification, (iii) Chemical treatment, followed by land treatment. The *newer* method is called biological treatment, and is as cheap as it is cleanly and complete.

Unless these facts are clearly borne in mind, difficulties arise in following the whole complicated course.

Necessity.—Indians drink any water, partly because they have little power to discriminate between safe and unsafe waters and partly because water as a rule, is either scarce in several places or a whole flat tract of a country may be waterlogged. Hence, any source of pollution of drinking water should be avoided. Ignorance leads Indians (*a*) to void urine and foeces into, or graze and wash cattle in or near, sources of water-supply ; (*b*) to perform wash and ablutions and to lead drainage of the house or village into the water, also used for drinking purposes. Hence the supreme necessity for purification and proper disposal of sewage in India, where copious good water-supply and municipalities are equally rare.

Composition of Sewage : Sewage contains three sets of stuffs : (1) *Organic matters*—urine, foeces, decomposing animal and vegetable stuff, slaughter-house refuse. (2) *Inorganic matters* : lime, clay, sand, stone, coal etc. (3) *Liquids* : from trade effluents, water-closets, kitchen, street drains etc.

Object of purification—is to render the potentially putrefiable mass into (*a*) maximum amount of comparatively *harmless* liquid and (*b*) minimum amount of *solid*,—thereby facilitating its removal or utilization for some economic purposes. The innocuous liquid thus obtained (*effluent*), is run into a water-course or utilized for manurial purposes and the solid (*sludge*) remaining over may be made into cakes of manure for sale or thrown into sea or dumped on waste land (which is both expensive and dangerous) or burnt (which is efficient but wasteful) or spread over surface of land or dug in (which is the worst way of disposing of it). Modern hygienists seek to purify it *efficiently* and *cheaply* without harming its *manuring* properties.

This purification is done chiefly by oxidation ; but sewage cannot be purified by oxidation en masse ; and un-oxidised sewage let into a flowing stream, kills vegetables and fish. **Rideal** tabulates the actual changes into *three* stages : (*a*) 1st stage of *Anaerobic Liquefaction* : the organic, gelatinous, albuminous matters, cellulose and fat are, chiefly by hydrolysis, converted into—soluble nitrogenous compounds, ammonia, fatty acids, gases and phenol-derivatives. (*b*) 2° stage of facultative *aerobic disintegration* : intermediate products of the first stage are converted into ammonia, nitrites and gases. (*c*) 3° stage of *aerobic nitrification* : Ammonia and carbon residues are converted into NH_3 H_2O, CO_2 and nitrates, chlorides and sulphates. [Crude sewage does, however, become purified naturally, if not too frequently discharged, in too large volumes and if the volume of running water be great. "The organic matter is oxidized (through the aid of nitrifying bacteria) by the oxygen dissolved in water and by that given out by minute water-plants (algae, diatoms, and desmids), and are also assimilated by minute animals (infusoria rhizopoda, entomostraca, anguillulae etc.)]

Classification of Sewage : (1) *Fresh* Sewage is that recent mixture of filth and preponderating mass of organic matters of all kinds (together with the waste water of a town) in which little mechanical, chemical or bacterial action has taken place and which generally contains free exygen and nitrogen in the form of nitrites and nitrates. (2) *Stale* Sewage is that in which the dissolved oxygen is exhausted, the free ammonia is increased and the crude organic matter has decreased. (3) *Septic* sewage is that foul-smelling sewage, in which the carbonaceous and nitrogenous matters are less, with no oxygen.

(A) OLD METHODS OF REMOVAL.

(WATER-CARRIAGE SYSTEM.)

After removal from houses, sewage was liable to disposal according to one or other of the following six means :—

I. Cesspool System (The purification secured was temporary and partial).—Dead wells of masonry work, cemented or not, situated on a lower level, 50 ft away from dwellings and 100 feet away to the leeward of sources of drinking water —cess pits formed *temporary* receptacles of excreta and foul water of houses. They *partially* disposed of the sewage by allowing solids to settle to the bottom, to be subsequently removed and trenched and the liquids to soak into or flow over the surrounding soil. If anywhere erected, now, they should be properly ventilated, trapped and regularly cleaned ; the liquid may be distributed over gardens by hand.

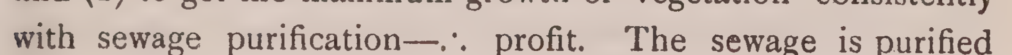
II. Discharge into River or Stream.—(*a*) **Crude** sewage must never be discharged into streams, as it kills fish, silts up the stream and, in India, where people drink directly out of the stream, becomes dangerous to life. (*b*) **Purified** sewage may be discharged into streams, the water of which is not used for cooking or drinking. (*c*) No known method of sewage purification renders it wholly germ-free ; hence, no *effluent* should be discharged into any water used for drinking or growing watercress or oysters. Effluent discharge leads to growth of lowly vegetable organisms in the stream, which may ultimately choke the stream and lead to formation of putrid black mud.

III. Discharge into Sea : (*a*) **Purified** sewage can be discharged anywhere into the sea. (*b*) **Crude** sewage can be discharged into the sea with four precautions regarding the outlet pipe : (*a*) it should be always below the lowest water-level (to avoid nuisance) ; (*b*) it should be carried well away from the town, to prevent fouling of foreshore ; (*c*) it should have a flap opening outwards (to prevent tide and wind blocking the sewer) ; and (*d*) it should discharge at beginning of ebb tide ; this last, in case of low-lying towns, necessitates the intervention of "**tank sewer,**" to store the sewer that flows down during the interval. Salt in sea water (*a*) retards oxidation and purification of sewage and (*b*) causes precipitation of organic matter as a deposit of mud.

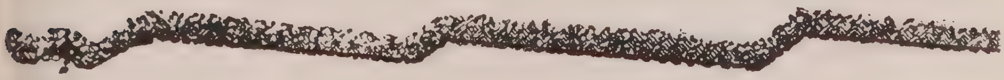
IV. Broad Irrigation or Sewage Farming.—Both this and the next one (Intermittent downward filtration) go under one category viz, **Land Treatment** of sewage.

Objects aimed at are—(1) To render the effluent innocuous and (2) to get the maximum growth of vegetation consistently with sewage purification—∴ profit. The sewage is purified partly on the same principle as in the next, and is partly used up by plants.

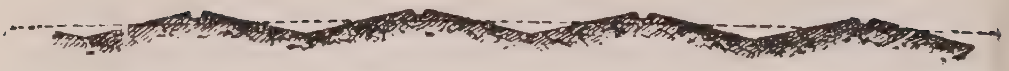
Details of the Scheme : (1) Select a *low-lying* agricultural land (to save expenses of pumping up sewage). The *area* of



BED IRRIGATION.



IRRIGATION ON TERRACES.



Ridge-and-furrow Irrigation.

land *wanted* is on the basis of 1 acre per 100 or 200 souls. *The land* may be friable loam, consisting of clay, sand and some vegetable loam, but chalk is better avoided. (2) *Level* it, and *under-drain it* by porous earthen-ware pipes (laid 6 ft deep and from 20 to 100 ft apart) to convey the effluent to the nearest stream. (3) The sewage used must be *fresh.* The application of sewage is *continuous.* (4) Secure *spread of the sewage* by one of these 3 ways: (*a*) For heavy and flat lands—lay out ridges 30 to 60 ft broad with well-concreted 10 inch gutters on them and furrows between two ridges,—the furrows having a longitudinal fall in the direction of the general outflow. (*b*) For steep ground—the catch-water plan may be adopted, trenches are dug in parallel lines, one below the other. (*c*) Pan and gutter method—with shallow channels made of tile or concrete.

Vegetation--As the realization of profit is a primary consideration on this system, *cattle* and *vegetation* are reared on the soil, specially,—potato, oats, grass, cabbage etc. There is absolutely no risk in eating the vegetable or meat reared on this farm.

Advantages :—(1) It is to some extent reproductive (*profitable*). (2) It is not detrimental to *health* and can thus be located near dwellings. (3) It *purifies* the sewage efficiently. (4) The *suspended matter* may be utilized for making cement or solid manure. [Enteric, cholera, foot and mouth disease, entozoal parasitic diseases, malaria have never been traced to well-kept sewage farms.

Itsdrawbacks : (1) It is unsuited for *alluvial* districts with much rainfall as in East Bengal. (2) *Very large area* of land is required, considering how costly land is now-a-days. (3) During *rains*, or when sewage is enormous in quantity, the whole arrangement is upset, owing to soil becoming soddened from ponding of sewage. (4) Sewage has to be *preliminarily* sifted; i. e., this method of disposal is unsuited to primary treatment of sewage—being a better secondary method. (5) Trenching ground being far away, *removal* creates nuisance (6) *Fly* and *mosquito* breeding grounds are formed.

V. **Intermittent Downward Filtration by land :—** The **principle** of its working is as follows :—*Loose* or *porous* earth (or friable loam or clayey, gravelly, sandy soil—but not peat or stiff clay)—harbours *bacteria* down to a depth of 3 or 4 feet; these bacteria, in the *presence of oxygen*, held in the interstices of porous soil, act on the organic portions of sewage, converting it at first into nitrites, then into nitrates, which, in their turn, combine with the minerals to form alkaline carbonates. The soil or sewage must be rich in *alkalies* or else the bacterial action is inhibited by the nitric acid formed. The sewage must be *fresh* and previously *sedimented*. The oxygen in the soil (∴ its fineness and porosity) is of greater importance than the composition of the soil itself, inasmuch as the nitrifying bacteria are aerobic and oxygen itself directly oxidises the sewage; hence, upward (*i.e.*, anærobic) filtration is no use, and prolonged rest to the soil is necessary to restore oxygen to its interstices.

The objects aimed at are : (*a*) to save *expenses* of sewer installation, (*b*) to render the effluent *innocuous*; (*e*) to get use of waste lands by raising *crops* thereon. For this last purpose, intermittent application of sewage, is necessary, so as to secure efficient nitrification of it. Crops are grown after the land has been given rest and broken up. Sewage is again run on after the crops have been removed.

Advantage : Less *expensive* than sewer installation, a *large* amount of sewage being purified by a *small* area of land.

Disadvantages : (1) Crops of vegetables, if grown, have to be *grown intermittently*; therefore, it is not so remunerative. (2) *Preliminary* treatment of sewage by screening, filtering, or precipitating is necessary. (3) *Engineering* difficulties are sometimes great. (4) Excessive *rainfall* spoils the working. (5) *Shallow wells*, and sometimes, deep wells near about it must never be used for drinking water.

Details of the Scheme : (1) Select a *porous* soil. If it is clayey, break it up and mix it with ash. (2) *Level* it and *underdrain* it with porous-tile-drains at a depth of 4 to 5 ft from surface and 10 to 30 ft. apart. (3) Divide it into four *plots* on ridge-and-furrow plan ; secure proper *fall*, to ensure proper spread of the sewage. Each area (= 1 acre) of land should be set aside for crude sewage of every 1000 persons or for precipitated sewage of 2000 to 5000 persons. (4) Work each plot *in rotation*, such that, it is flooded with sewage for 6 hours and left alone for 18 hours.

VI. **Chemical Treatment.**—This does *not purify* but simply *precipitates* or clarifies the sewage into two parts—(*a*) the liquid **effluent** (which contains the bacteria and putrescible organic matter and is therefore of manurial value) and the moisture-laden **sludge** (which contains minerals and suspended organic matter). The effluent can be discharged into streams of *large* volume, without creating much nuisance ; but the sludge is either dried or pressed into manurial cakes or mixed with lime and clay and burnt to make cement. For chemical treatment **to be effective,** (*a*) the sewage must be fresh ; (*b*) the larger solid bodies must be strained from it beforehand ; (*c*) the chemicals should be added hot and efficiently mixed up ; (*d*) the sludge must be periodically removed. The precipitants in common use are :—

The Chemicals used are tabulated below :—

Quantity per gallon	*Name of Chemical*	*Advantages*	*Disadvantages*
12 to 15 gr	Slaked Lime (Blyth's = lime and phosphate of magnesia)	Simple, cheap, effective, of manurial value	Does not remove organic matter ; kills fish.
5 gr	Sulphate of Alumina [Bird's = subsequent filtration through coke]	[Combined with gr 5 lime per gallon] Removes 5% of dissolved organic matter	—
2 to 5 gr	Protosulphate of Iron [Holden's = $FSeO_4$ and Ca CO_3 and coal dust and clay]	Addition of lime removes 18% of oxidisable organic matter	Blackens the banks of stream. Does not remove organic matter
2 to 3 gr	Ferrozone or Alumino Ferric, Polarite	—	—
167 gr	Sellar's ABC (alum, blood, clay, charcoal)	Effluent clear. Sludge is dried and sold.	—
0 to 50 gr nd 3-4 gr	Amine's process (= milk of lime and herring brine) = methylamine	Renders sludge and effluent non-offensive in odour, rapidly	—
—	(1) Partially electrolized sea water (Hermite process) (2) Bleaching Powder	—	Hardly effective, costly, destructive to metal parts
—	Oxychloride process	Reduces B. coli. Is non-poisonous ; effluent is of manurial value	—

B. MODERN METHODS OF REMOVAL.

On this system, called the *biological system* or *bacteriolysis*, purification (without loss of its manurial value) and disposal of sewage are *simultaneously* arranged for. This system is worked in one of two ways,—the differences between which are :—

Septic Tanks.	**Filter Beds.**
*An*aerobic bacteria act in the beginning	*Aerobic* bacteria act throughout.
Effluent requires *subsequent aerobic* action	Effluent requires *no subsequent* treatment.
Worked *continuously*.	Worked *intermittently* ; *slime* formation is essential.
Scum formation is essential.	Takes four weeks to mature.
Only *one type* exists—with two chambers—grit and actual septic tank chambers.	They are of *two classes*—percolating filters and contact beds.
They do create *nuisance*.	They do *not* create *nuisance*.
They *liquefy* solid organic matters.	They *nitrify* or purify the sewage.

The theory of the working.—It is the oxidising power of aerobic bacteria that purifies sewage ; and happily, sewage contains all the elements of its own destruction—*bacteria* and their *organic* food—in abundance : it is only necessary so to arrange plans as to afford (*a*) *time* for the bacteria to develop ; (*b*) *light-and-air-tight* compartment for the anaerobic bacteria to work in,—these anaerobic bacteria doing the preliminary work of liquefying crude sewage ; and (*c*) *aeration* of filter beds,—to help the nitrifying aerobic bacteria in their final work of purification.

Classification of Biological Installation :—As tabulated above, there are two means of attaining biological purification :

(*a*) combination of preparatory anaerobic process with aerobic (or nitrifying) process—as in septic tanks; or, (*b*) wholly aerobic process,—as in contact beds. In India, with a more or less purely vegetarian population (∴, whose excreta contain little H_2S), the septic tank is recommended, because of its cheapness, ease of management and efficient nitrification.

Schematic outline of Biological Installations generally.

The steps that secure the purification are successively:

I. **Preliminary treatment** of the sewage so as to *clarify* it of *mineral* or other *inorganic* matters; this is done by—

1. PHYSICAL means, which are three: (*a*) *Screening*—of extraneous matters like rags, garbage, straw, paper, cork, etc.; (*b*) *Subsidence*—of heavy particles; and (*c*) *Straining*—of suspended fine particles through ash, charcoal etc.

2. CHEMICAL TREATMENT:—(*a*) *Precipitation*—by calcium carbonate, alum, ferrous sulphate, ferrozone, alumino-ferric, ABC process, etc. (*b*) *Disinfection* by —manganate of soda, sulphuric acid, amine process, oxychloride process, hermite process.

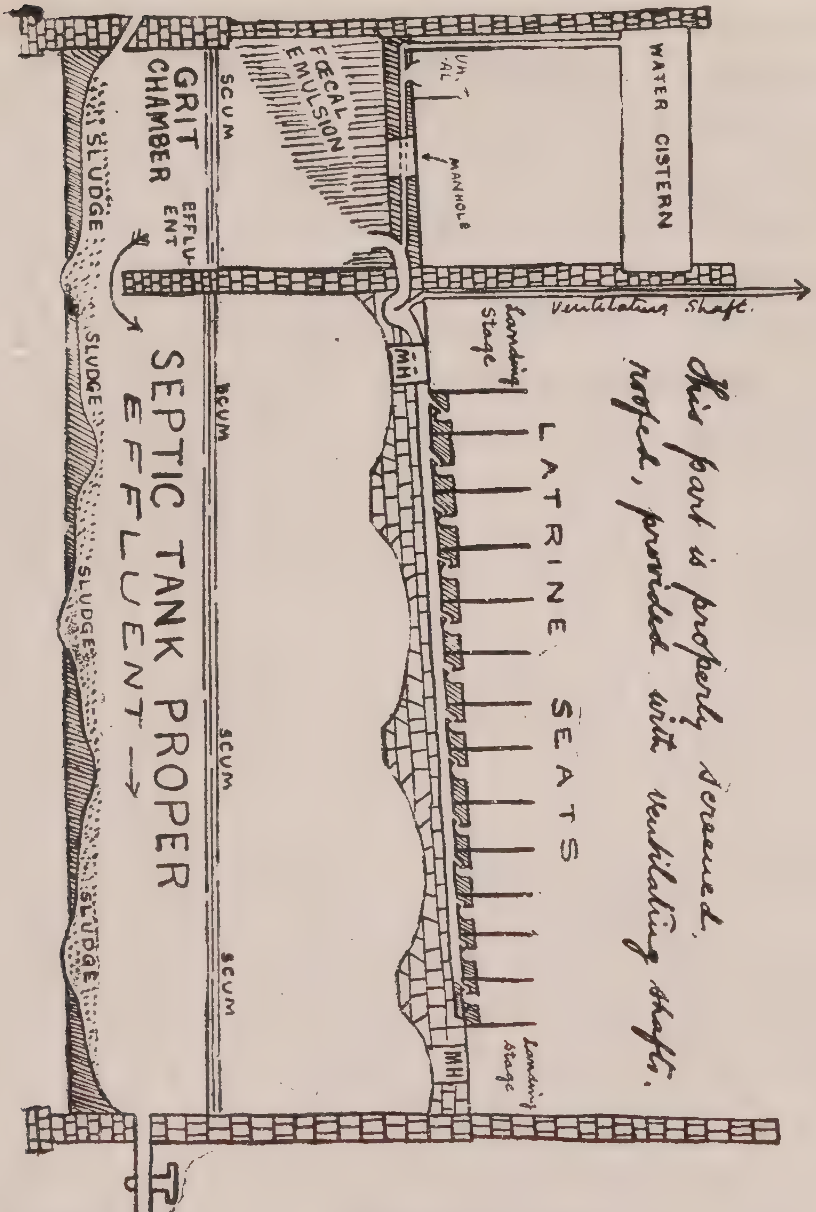
II. **First or Anærobic Stage** of bacterial *clarification* (not purification)—whereby solid *organic* matters are broken up and liquefied, chiefly into ammonia, by a process analogous to that of digestion. This is only a preliminary work with *organic* matter.

III. **Second or A erobic stagee**—*i.e.*, of real *purification* (also called nitrification, mineralization, oxidation) of unstable solid and liquid products of first stage into nitrites, nitrates and carbonates. This secures our end in view.

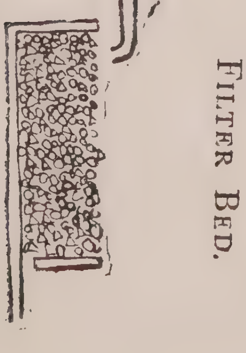
The working of the biological treatment is best illustrated in the following table of the important installations now found :—

Whose Installation	First Stage (anaerobic)	Second Stage (aerobic)
Scott-Moncrieff	Upward flow cultivation tank. Large stones at bottom, smaller ones above	Nitrification channel (Replaced by modified hollow tank)
Sutton	Downward filtration through coarse beds	Fine contact beds (intermittently worked)
Dibdin (original)	Large coarse bed	Fine contact bed in series
Cameron	Air-tight septic tank	Intermittently working contact beds
Dibdin's modification of Cameron	Slate-bed filtration	Contact bed
Ducat	Upward filtration tank combined with,	Aerating filter situated above it

I. SEPTIC TANK INSTALLATION.



This part is properly screened, provided with ventilating shaft.


FILTER BED.

Remember that the septic tank proper is no *essential* part of the biological process, being merely a preparatory stage or a helpful process in the aerobic purification—a modernized cess-pool or well privy. A Filter bed in connection with it, but situated wholly outside of the Tank building, is the real purifier—to which the huge tank installation is but a preparatory appendage.

Varieties: (1) **Septic Tank Latrine**—when the tank is directly used by the people, a series of latrines being fixed over it. The number of latrine seats is roughly one for each fifty men. This is the kind we shall always refer to. (2) **Dumping Septic Tank**—where the tank receives the night soil from individual and private privies.

The component parts of an installation are: (I) A two storied building and (II) a Filter Bed. The upper storey contains urinals, latrine seats, flushing cisterns; the *lower* storey, which is somewhat sunk in the soil, contains (*a*) a receving chamber called the grit chamber and (*b*) the real septic tank chamber.

Conditions essential to the successful working of a tank are :—(*a*) Free supply of filtered water, so as to *dilute the sewage* (5 to 12 times) into a good emulsion : (*b*) *Outfall for the effluent*—in the case of latrine tanks, into running streams via filter beds, and in the case of dumping tanks, to cultivation farms; (*c*) arrangement for periodical *cleaning* of the non-smelling sludge. Sludge should not be allowed to be deposited more than 12 inches. (*d*) *Sufficient time* is an important element for the bacteria to develop. In a hot country, a stay of 6 to 12 hours (upto a maximum of 24 hours in cold weather) inside the tank is quite enough for the sewage. But if sewage is diluted with 5 gallons of water per head, as it is in India, a stay of three days is desirable.

Details of construction.

I. **The Grit Chamber**—*is meant to* keep back silt, brickbats, coal, garbage, paper, clay, lime, hard lumps of foeces etc., from going into the septic tank proper. *It forms* an eighth part of the septic tank itself, and is three feet deeper than the latter. *It receives* the fresh sewage and soil water and is air-and-light-tight. It *communicates with* the septic tank proper through grids placed towards the bottom, or, better still, through a series of small openings midway between the bottom and highest water-level of that chamber. There is an *inspection manhole* on its top, which is usually kept covered.

II. **The Septic Tank Proper.**—*It is* a concrete tank, air-and-light-tight. *Its capacity* is such that it can hold two to three days' sewage, including storm water*—in order to ensure slow passage of sewage into, through and out of it, so that every particle of organic matter may be efficiently exposed to the action of the anærobic bacteria. The farther the septic action advances in this stage, the easier is the nitrification at the next stage, outside of the tank. *It receives* the emulsified sewage from the grit chamber in an almost imperceptible stream and *discharges* its own clarified effluent at a point half way between the scum and the bottom, into filter beds or running streams.

DETAILS OF CONSTRUCTION : *Shape*—Rectangular. *Length* should be six to fourteen times the breadth. *Depth*—6 ft., with another depth of 15 inches to allow for heading up. A *fall*—of 1 foot towards the outlet end. *When a new tank is ready*, it should be filled with clean water and a quantity of liquid sludge, enough to cover the bottom of the tank for an inch, should be introduced from another tank in active operation (*inoculation*) and only a third of the total number of users should be allowed. *Effluent outlets*—should be three in number and placed equidistantly. They should dip down one third of the minimum depth of liquid in the tank. Their combined discharging capacity, under the head of water, which will obtain at the time of maximum sewage delivery, should not be more than can be dealt with readily by the attached filter bed. *Manholes* for inspection should be placed (*a*) over the grit chamber, (*b*) at inlet end and (*c*) at outlet end of the main septic tank.

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* Six times the dry weather flow is the minimum allowance that must be made for a storm water. An overflow weir is always provided to the grit chamber to remove excess storm water.

The digesting and liquefying action * commences in the grit chamber and goes on well in the rest of the tank. During their stay in grit chamber, solid foecal matter undergoes ammoniacal fermentation, thereby losing over 50° %. of total nitrogen =80 % to 90 % of total purification. "The particles of organic matter, when they first enter this tank, sink to the bottom; then a minute bubble of gas (=CO_2, CH_4, H, N etc.,) forms on each small lump, and lifts it up to the surface, where it discharges its bubble of gas and then falls to the bottom again, but probably not without receiving a thousand microbes which will, in their attack on the organic particles, produce more gas and once more lift it up to the surface, to procure more microbes. Owing to the slow current through the tank, this up and down motion of particles does not take place in the same vertical plane each time and there is thus a transference of particles in various stages of disruption and demolition from one end of the tank to the other. In the Tank proper the troublesome colloidal material of sewage is largely disposed of and it is this colloidal material that absorbs dissolved oxygen freely.

The Result: *Sludge*—falling to the bottom, is inconsiderable in volume, being made up chiefly of—minerals, cellulose, vegetables and elastic fibres, carlilage cells. After periodical removal, it can be trenched. (2) *Effluent*—is dirty-looking, ammonia-laden and contains but few grains per gallon of fine suspended organic matter. (*c*) *Gases generated* inside the tank are—H, CH_4, H_2S, CO_2, N, carburetted hydrogen. These can be utilized for illuminating the installation. [See remarks on disposal of sludge and effluent elsewhere].

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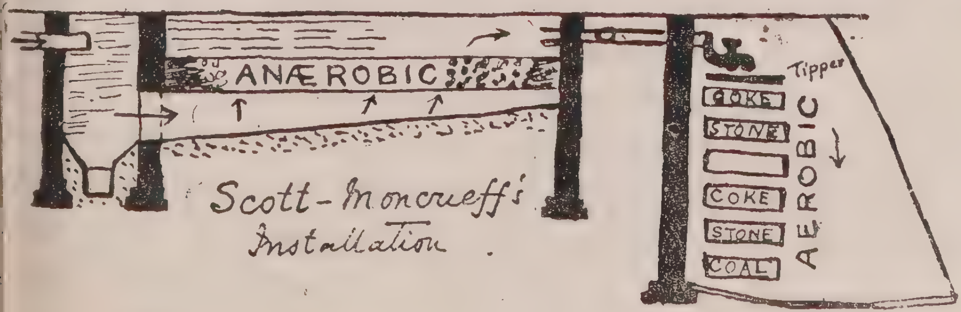
* Adeney recommended the addition of nitrate or manganate of soda to the sewage to add to the available oxygen.

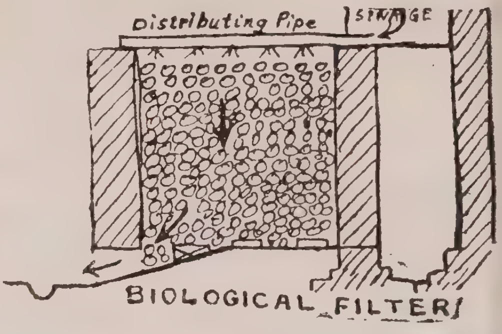
II. BACTERIAL FILTER BEDS.

Principles of action.—They combine the anaerobic with the aerobic bacteria and are real sewage purifiers ; in them, the sewage is rendered practically harmless by the aerobic bacteria. *Efficient oxygenation* of the filter beds is, therefore, a great necessity ; to ensure this, the largest number of organisms is applied to the smallest area of sewage and adequate air-space is provided between the sewage particles. The bacteria that purify the sewage are planted on the filters as a slimy layer, by the sewage itself ; but, not until after some days, do they develop sufficiently in activity to produce the best results ; even then, it is necessary to intelligently regulate their work and rest (by controlling the sewage intake and the effluent output), so as to stimulate them without exhausting them. Roughly speaking, it takes a biological installation one year to develop full activity.

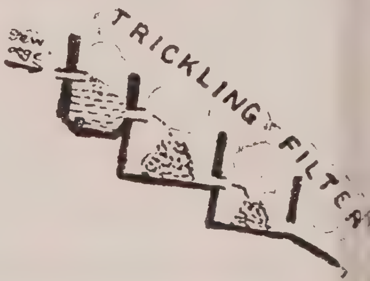
Classification.—According to the method of applying the effluent to the beds, filters are divided into two classes—Percolating or streaming filters and Contact Beds.

I. **Percolating Filters.**—*Also called*—aerating, continuous, streaming. They are *suitable for*—(*a*) tracts with a large fall





(as in a hilly country) and (*b*) treated sewage—*i.e.*, sewage that has received chemical or bacterial clarification—never crude sewage. They are *made of*—pan breeze, clinker, burnt ballast, broken granite, jhama, slate, sand, gravel, coal, polarite etc. arranged upon a concrete floor (no walls being necessary) laid with sufficient fall. The clinkers etc. must be very carefully *graded* from above downwards, so that the smallest ones occupy the top. Sewage must *continuously* trickle down in the *thinnest possible* stream—being never held up anywhere. The sewage is to be *applied* over the whole upper surface of the filtering bed in fine streams of drops, such that, at no time, in any part of the filter, there shall be any visible liquids. The surface requires to be *scraped* once a month. Their *advantages* are: (*a*) continuous, automatic oxidation ∴, purification of a large amount of sewage; (*b*) simplicity of construction and management; (*c*) rapidity of action, (*d*) occupation of a comparatively small area; (*e*) they do not breed flies or create nuisance.



II. **Contact Beds.**—PRINCIPLE OF ACTION: A large amount of effluent is poured into a prepared bed which it *fills*; after two or four hours, it is discharged *wholly* from that bed. Thus, there is alternate application (or contact) of sewage by its bein held up and its non-application—not a continuous trickling i impalpable drops. SUITABLE FOR flat countries with littl dependable fall. PARTS: (*a*) An *impounding tank*,—fro which the effluent is to be run out into the bed at state periods ; (2) the *contact bed* itself—is made of masonry tanks, not more than 4½ feet deep (to allow of filling and emptying within specified period of time). The bed is FILLED WITH broken jhama (overburnt brick), stones, flint, gravels, clinkers &c. It is not necessary to nicely adjust the grading of the jhama, but it is necessary to have them in very *small* size, so as to increase the area of contact within a given size of bed. About 25% of their cubic capacity is what is ultimately available for efficient working ; and with a strict eight hourly cycle, one million gallons of sewage per acre per diem can be worked. WORKING* : Alternate periods of (1) *Filling* (1 hour) :—During this period, oxygen from the zooglœa layers on the stone and also from the previously oxidised sewage remaining behind in the interstices of the contact beds, is absorbed by the crude sewage. (2) *Standing full* (2 hours.)—During this period, the surface sewage is acted on by aerobic and the deeper layer by anærobic bacteria—whereby the stable organic matter is reduced into an unstable form. (3) *Emptying* (1 hour). (4) *Standing empty* (4 hours)—during which, the zoogloea scum on the clinkers &c. is oxidising the sewage particles left. [This sewage helps to oxidise sewage freshly let in later on]. During this, the unstable organic matter is broken up into ultimate products. The ESSENTIALS OF THEIR WORKING ARE : (*a*) They must not be very deep—or else filling and emptying are unduly prolonged. (*b*) The eight hour-cycle must be regular, both in order and timing. (*c*) With stronger sewage, the number of contact beds must be increased or the period of rest must be prolonged considerably. (*d*) The drainage of the bed must be efficient and quick, to allow of aeration rapidly. (*e*) The period of contact should never exceed 4 hours or else the aerobic bacteria will die. (*f*) The beds require renovating in 3 to 5 years' time.

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* Some advise : 1 hour to fill + 1 hour to empty + 4 hours to remain full + 8 hours to remain empty. In fact the timings should depend on the amount of nitrogenous material per gallon of sewage.

Advantages: Where the available fall in slight, with a shallow but large bed, the purification is more efficient and rapid for larger area than that by irrigation or land filtration.

Note—(1) that sewage rich in *fat or soap* is resistant to bacterial action, because of the tendency of fat to coat the particles of which aerating beds are made; (2) that multiple filter beds are necessary where alternately strong and weak sewage or only *strong sewage* is the rule; (3) that even in the coldest winter, the *temperature* of bacterial filter beds rarely falls below 50°F; hence it is unnecessary to warm it; end, (4) that, of the 2 methods, the streaming filters are more efficient oxiders than are contact beds.

Remarks—If minimum of expenditure and maximum of efficiency be our aim, then, by itself.—

1. *Sedimentation*—is cheap but inefficient. *Straining* (through ash or charcoal)—is expensive and unreliable.

2. *Precipitation*—is costly, owing to cost of chemicals and of sludge-removal.

3. *Septic Tank*—is productive of nuisance; its filter-bed becomes inefficient in the presence of storm water; the tank itself too, becomes inefficient from the presence of very concentrated sewage from, say, barracks.

Tests of Purity of Effiuent.—The following table furnishes the standards at a glance:—

Ingredients.		Proportion per 100,000, in—		
		Crude Sewage.	Purified effluent.	Standard of purity
Solids	Suspended organic	20·51	1·50	—
	Suspended mineral	24·18		
	Dissolved	72·2	86·15	—
Nitrogen	Total combined	7·728	——	Large quantites (Nil)
	Oxidised	——	1·00	
	Organic	2·205	——	
Ammonia	Albuminoid	0·63	——	
	Free	6·703	1·50 + Saline	
	Organic	——	0·12	
Chlorine		10·66	10·00	6 (6)
Oxygen absorbed in 4 hrs at 80° F			1·40	1·5 (3·5)

An effluent is satisfactory when it is—(*a*) without odour of foeces or of H_2S; (*b*) without marked deposit; and (*c*) is incapable of putrefaction, when incubated at 80°F for a week in a closed vessel. The effluent should not contain per 100,000 parts more than—

(*d*) 0·1 to 0·2 parts organic ammonia.

(*e*) 1·5 parts absorbed oxygen in 4 hours, at 80°F.

(*f*) 1 part of dry organic matter in suspension

(*g*) 3 ,, of ,, mineral ,, ,, ,,

[The presence of oxidised nitrogen in an effluent is no test of its purity—because, nitrates are a measure of the pollution that has been oxidised and not of what remains to be oxidised].

The Standard of Purity laid down by India Government are :—

The effluent—must be clear, free from foecal odour, non-putrescible, nitrification shall have thoroughly commenced.

		Filtered.	Unfiltered.
Physical character		Clear, Earthy odour	Hazy, No foecal odour
Chlorides		6·0	6·0
Four hours' oxygen		1·5	3·5
Dissolved O remaining	24 hrs	·45	·25
	48 hrs	·25	·1
Nitrates		In large quantities	nil

DISPOSAL OF EFFLUENT :

Clowes & Houston hold that—"the effluent from bacterial beds ought to be regarded as hardly, if at all, more safe in their possible relation to disease than the raw sewage before treatment." This unchallanged statement, coupled with the fact that there is eternal want of good drinking water in many parts of India, makes the discharge of an effluent into a source of water supply, to say the least of it, criminal.

The effluent can be disposed of thus :—

(*a*) (i) If thoroughly ærated—it may be discharged into the mid-stream of a fast-flowing large-volume river, where it is rapidly diluted.

(ii) Discharged into a pond, suitably fenced and stocked with lotus and haplochilus fish : this causes no nuisance.

(iii) After sterilizing it with chloride of lime, and thereafter exposing to air and sunlight, it can be run into a river.

(*b*) If not ærated :—(i) By spreading over land. [If the effluent has been filtered in the aerobic beds, it contains less colloidal matter and has less chance of clogging the soil ; or else, (*i. e.*, if unfiltered) it will rapidly clog the earth and therefore, a very large area of land will be required.]

(ii) Into the sea—below ebb-tide level.

(iii) In the boiler of engines—to be there utilized.

(iv) By trenching.

CHAPTER XX.

DISPOSAL OF THE DEAD.

Issues involved : Dead bodies may be those of men or of animals. We refer to *human corpses* in this chapter, treating towards its end, about *animal carcasses.* Custom, superstition, sentiment and religious obligations seem to determine the manner of disposal of a corpse in each part of the world. But there are three other equally important considerations, *viz.*, those of hygiene, economy and expediency. *Hygiene* demands that form which least pollutes air and water (the soil of cemeteries being rich in harmless bacteria) ; *economy* demands that, which is the least expensive and at the same time gives something in return ; while *expediency* demands a process that is the swiftest and least troublesome.

Methods in vogue :—Broadly speaking, there are three methods in vogue in different parts of the world, *viz*,. (1) *Burial*—under stone-heap, under earth, inside vault (embalmed or otherwise), in cave, in sea or river ; (2) *Cremation*—in the open or in properly-constructed crematorium ; and (3) *Exposure*—(*a*) either to the air, to secure mummification of the corpse ; or (*b*) to *anthropophagous* men, vultures or beasts. Of these, cremation in a crematorium is the speediest and cleanliest method, earth-burial is the most economical, provided old graveyards are used for cultivation.

Burial.—The Cemetery : It should be SITUATED—in the suburbs, 500 feet away from all existing and future buildings. THE SOIL must be (*a*) light, open and porous, (*b*) naturally or artificially under-drained, so as to reduce the level of subsoil water to below 10 feet from the surface and (*c*) should be at such ow level, that water from it will not flow towards surrounding sources of water-supply. [Dry *loam* or *sandy mould* is the best; *clay* retards dissolution, emits gases through fissures and tends to form adipocere; *chalk*, having cracks, will, foul air and water: *loose gravel*—emits gases freely]. But, obviously, a water-logged soil or one liable to floods or encroachments by sea or river is not to be selected. The SPACE REQUIRED is estimated by the equation—

$$xz + \frac{65y}{100} \times 14 \times 4 + \frac{35y}{100} \times 8 \times 2 = x,$$

where x = area required (in sq. yd.), y = number of deaths per annum, z = population of the whole area unoccupied by the graves. The space, roughly speaking is one acre per 1000 person for 50 years. The whole area should be divided up into *plots* with PATHWAYS between. VEGETATION: Avoid turfing the ground over; but plant trees, as they absorb CO_2 and dry the soil. JACKALS must be carefully excluded from cemeteries. [Cemeteries as a rule emit CO_2, H_2S etc, into the neighbouring sewers and atmosphere and in the case of Paris vaults, the neighbours suffered from sore throat, general ill-health, diarrhœa etc.]

Rules of burial: (1) The object of burial is to secure quick disintegration of a corpse and removal, by oxidation, of the products of its dissolution. The perishable parts disappear in about a year, in true earth-burials. *Avoid*, therefore, (*a*) any kind of coffin,—specially heavy lead and wooden coffins, (*b*) brick-built vaults and (*c*) caves. Wrap up the corpse in paper or cloth and use *quicklime*, which facilitates the resolution of the corpse. (2) At least 10 feet of soil ought to be available above the ground-water-level. In such a soil, graves are not to be more than 8ft. *deep*,—there being at least two feet of soil *intervening* between the bottom of the grave and subsoil water; because, for every foot of depth below the soil, about one year is necessary for resolution of the corpse, the nitrifying organisms residing in the upper 3 or 4 feet of the soil. Four feet of soil must *cover* an adult body and 3 feet that of a child under 12 years of age ; and a foot of earth must *interpose between* two coffins in the same grave. Each corpse requires on an average—9ft. × 4 feet (adult) and $4_2' \times 4$ ft. (child under 12.)

Mortuaries—are necessary in connexion with cemeteries, to prevent the evil practice of keeping dead bodies in crowded poor men's houses. If mortuaries are erected, corpses of the poor may await burial. Old filled-up burial grounds may be **utilized** either as cultivation fields or as open spaces or parks.

Embalming (1) *Egyptian method.* Remove abdominal viscera by incision on left side, cleanse the cavity with palm oil and stuff it with myrrh, cassia etc ; then wrap the body in numerous layers of cloth and seal it up hermetically. (2) *Modern method :*—Empty chest and abdomen of their viscera, wash the cavities and viscera with camphorated spirit or other antiseptics, and then replace them. The aorta is injected with 6 to 8 pints of a mixture of arsenic, perchloride of mercury or of carbolic acid, glycerin and alcohol. (3) *Latest method* : Expose the body in ice-closet to the vapour of formic aldehyde for 3 or 4 weeks.

Cremation.—It is the *swiftest* method, because it takes about 2 to 3 hours to reduce to ashes an adult corpse ; it is the *cleanest*, because it not only destroys the body but also all foci of infection existing in the body ; it is the *safest*, because it leaves no room for pollution of soil, air and water ; and it is the *cheapest*, because only a few rupees worth of fuel is all that is required. The only objection to cremation is that it facilitates the concealment of murder. But this can be easily safeguarded by insisting on medical certificates. It is of two KINDS : (1) **Open cremation :** This, as practised in India, is insanitary in several respects. It is practised by the side of rivers, in open places ; the cremation is not always complete and the custom exists of throwing the charred navel into the water. The smell given out is not pleasant, but it is not hurtful. Specified enclosed areas, 500 ft. away from human habitation, should be erected and complete cremation should be done.

(2) **Crematorium** : In it, there is no exposure and the body is consumed by gas given off by furnace at 1800°F to 2000F ; in about two hours, a body is reduced to three pounds of odourless inorganic ash—all offensive gases being burnt during their passage through a furnace. The fuel used is coke, coal or gas.

Exposure.—(1) The Australian aborigines *mummify* the body by exposure. (2) *Cannibals* eat up the dead. (3) The *Parsees* expose the corpse, in Towers of Silence (*Dakhmas*), to vultures, which pick the bones clear of flesh within a few hours to a week,—the trickling fluids being collected with dry bones in a large pit, where they become fine impalpable powder. (4) *Criminals* in India throw murdered corpses into wells or rivers or expose them to jackals in jungles.

ANIMALS : Carcasses should be burnt or covered with quicklime and buried. They should not be deposited in dust bins or village refuse heaps. Carcasses of plague-stricken rats should never be handled or thrown into streets but covered with kerosene and burnt on the spot, if possible.

CHAPTER XXI.

PERSONAL HYGIENE.

This refers to matters touching the health of an individual and to factors conducive thereto, such as—Constitution, Heredity, Temperament, Idiosyncracy, Age, Sex, Exercise, Rest, Clothing and Habits.

Constitution—is the natural condition of the body. It is partly inherited and partly acquired ; it may *naturally* by heredity, be either feeble, delicate, or strong or it can be (*a*) *made* strong on the one hand by prolonged, steady, moderate exercises and strict attention to hygienic laws or (*b*) on the other, *made* delicate by dissipation, neglect or continued unhygienic conditions. It is a great asset in recovery from diseases, specially when the constitution is robust and strong.

Temperament—is the natural organization of the body, with special reference to physical and mental peculiarities. Those who are *sanguine* are excitable in nature, being the reverse of the *phlegmatic* (*or lymphatic*) ; the *bilious* are capable of considerable mental and physical endurance ; while, the *nervous* are explosive. Temperaments create predisposition to certain types of diseases and have to be reckoned with at the time of recovery and in reference to climatic conditions.

Idiosyncracy—is the peculiar behaviour of the constitution towards *certain* articles of diet or medicine etc. This is a great factor in precipitating attacks of certain diseases—like asthma after inhaling pollens or urticaria after eating eggs ; it is a great trouble too in the treatment of its owners—for, in them, certain drugs act most intensely in minute doses or even contrarywise ! Thus, opium may convulse, quinine may collapse, magnes-sulph may constipate.

Heredity.—It usually transmits a special *proneness* to parental diseases or deformities rather than that it actually transmits the disease itself. Gout, insanity, epilepsy, asthma, hysteria, tuberculosis, syphilis - are particularly hereditary. When the taint skips over one generation and visits the next, the phenomenon is called ATAVISM.

SEX. *Females* are susceptible to certain diseases and disabilities as are human beings of all sexes, at certain phases of their lives. Thus—females require special care during the periods of their *menstruation*, *pregnancy*, *delivery* and *menopause*. During these periods, their food, exercise, bath, mental work —every thing requires special attention. The **dress** of the woman too requires attention, so that it may not become an engine of torture to her viscera. Thus, tight-lacing of waist and wearing high heeled boots in Europe are to be denounced as also the use of small iron-shoes in China. In *educating* girls, special attention should be paid to the possibilities of their motherhood and their position in a family as well as in society.

AGE. Irrespective of sex, life is divisible into the three EPOCHS :—infancy, youth and old age. During *infancy* and **childhood**, teething and feeding are very big questions. Faulty feeding can lead to rickets as well as to fatal bowel complaints. Children should, as a rule, be kept warm. In **youth**, there is danger of underdeveloping by over-attention to studies and under-attention to dieting and exercise. A young man requires comparatively more and better food and his education should be nicely adjusted to his capabilities. The reverse of this is met with in India. When a youth reaches manhood, which is the sum total of what he has eaten, he requires little special care. But when **old**, he should spare himself emotions, and excitement, excesses in food and drink, and lead an even tenor of life.

HABITS—once formed, become our second nature, be it in respect of our physical health or of our morals (character) and on the formation of good habits depends our weal or woe.

Habits pertain to—(*a*) Eating and drinking (*b*) Easing ourselves (*c*) Exercise, (*d*) Rest and recreation and (*e*) Cleanliness.

Eating. The child and the youth require to eat a good deal but the inactive old man with degenerate arteries and failing excretory organs, requires to eat less. As a rule, whatever one's age, one should—(*a*) Eat at *regular hours*, as eating off hours is a menace to digestion and an invitation to biliousness. (*b*) Eat *slowly*, *masticating* each mouthful till it becomes completely fluid. If the teeth are faulty, they should be attended to without delay. It is a grievous blunder to look upon faulty teeth with unconcern, as it is to forget that successive stages in the digestive process are of a piece with the first step. (*c*) Never *eat to excess*, specially never eat too much of spices, condiments or meat. (*d*) Do not eat unless *the appetite* is really there. (*e*) Do not occupy yourself at meals with any *serious occupation*. **Drinking** *alcoholic* drink at meals is not a necessity ; if one does drink, one should drink only small quantities of light wines, well diluted with water, and that in sips during meals. *Plain water* drunk to excess before, at or immediately after, meals retards digestion. Only small sips should be allowed. *Tea*, *cocoa* or *coffee* should never be drunk with meals, specially with those in which meat is taken. They may be drunk two or more hours after a meal. (*g*) *Fasting* is badly borne by children and old men and better borne by adult females.

Smoking.—This is not a necessity. It soothes a tired body but when chronically or excessively indulged in, it leads to—cancer of lips and tongue, chronic pharyngitis, irritable heart, fainting fits and even sudden death. Smoking the hooka (hubble-bubble) is a less toxic form than smoking the cigar, while cigarettes are adulterated with morphine etc. *Taking snuff* is another useless, dirty habit that causes chronic cattarh of the nose and blunts the sense of smell. *Chewing tobacco* is the worst form of using tobacco and it rapidly tells on the heart and the stability of the nervous system.

Easing oneself—One should not delay in answering the calls of nature. It is a very good habit to form early in life to have a *stated* period for easing oneself. Neglect of this leads to intestinal stasis and all its attendant symptoms. It is not a good habit to take a purgative regularly once a week, fortnight or so; by using stewed fruits, oatmeal or bran bread and by regular physical exercises, the bowels should be induced to act regularly.

CLEANLINESS.

As a habit, cleanliness is really next to godliness. A man who is cleanly in his habits always insists on clean food, drink, dress, person, atmosphere and thoughts. Cleanliness is a bar to loathsome skin diseases and to infections and is a direct help to rapid recovery when one is actually ill.

So far as our body is concerned, it is provided with three things of its own that make for uncleanliness: (*a*) secretions of sebaceous glands of skin—which give out an unctuous substance; (*b*) the epidermis—which is easily and constantly peeling off; and (*c*) the sweat glands which give out with the sweat, salts which are hygroscopic. The salts imbibe moisture from the atmosphere and keep the epidermis sodden; the sebum mixing dirt with the epidermis keeps the latter adhering to the body. This is specially the case in the tropics and with persons of sedentary habits, for, in those who labour hard, the streaming perspiration helps to wash off part of the dirt. In those persons on whom this mixture of salt, epidermis, dirt and sebum occurs, clogging of the orifices of the sweat and sebaceous glands leads to formation, at first, of unsightly *black spots* at the sites of orifices and, later on, to *acne* and permanent disfigurement.

Clogging of orifices of sweat glands means retarded cutaneous action and hence vicarious overburdening of kidneys and lungs and ultimately disease of these last organs.

It is necessary therefore to keep the skin clean, specially so in the tropics and by individuals of sedentary habits. *To keep the skin clean* three things are necessary,—plenty of water (preferably warm), good soap * and rubbing. These are required regularly to ensure due action of skin.

Soap.—is an alkaline stearate formed by the chemical action of an alkali on an oil. Caustic soda or potash is usually mixed with linseed, castor, poppy, groundnut, or cocoanut oil or bone fat, whale or seal oil or sheep or ox tallow, etc. Though individually alkalies are irritant to skin and oil causes dirt to adhere firmly to skin, yet these two, when chemically combined, form the ideal cleaners. When soap comes in contact with water, it is decomposed ; its alkali (Na or K), weakened in its caustic property by dilution with water, unites with and removes from the skin the unctuous dirt thus rendered miscible in the water used for washing. The soaps commonly found are :—

Name	*Usual composition*
Hard soap	Na—stearate
Soft soap	K—stearate
Yellow soap	Resin + tallow + palm oil
Marine	Alk + cocoanut oil
Toilet	Lard + alk & refined
Glycerine	Ord. soap + Glycerine
Transparent	Dissolving ord. soap in hot spirit and then distilling spt. off.
Silicated	Ord. soap + Na silicate

Normal soap contains 5 to 35 % water ; the addition of silicate of soda enables the soap to contain 70 % water.

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* In India, daily use of soap leads to an irritable state of the skin. Among the Indians, the custom exists of anointing the whole body with mustard or cocoanut or til *oil* before a bath, all the year round. This helps to keep the skin smooth and free from irritation. But in summer it renders the heat unbearable and the body unspeakably dirty. If accompanied by shampooing and massage before a bath, and by soap during the bath, inunction of oil has much to recommend it.

Hardness of a soap is in proportion to the stearic and palmitic acids and requires the use of non-drying oils.]

Baths : Objects of bathing*—are three : (*a*) cleanliness ; (*b*) production of a "shock" to the nervous system, so as reflexly to excite a better circulation throughout the body ; and (*c*) abstraction of heat. A bath to be of benefit must conform to the following rules :—(1) *Regulation of Temperature* of bath : A bath is "very cold" when the water has a temperature ranging between 32° and 50° F ; cold, 51° F to 60° F ; Fresh 61° to 75° F ; Tepid 76°—88° F. ; Warm 89°—99° F : Hot, 100° to 110° F. (*a*) Those who are healthy, young and strong should take a daily morning *cold* bath after breakfast. (*b*) *Warm* bath is suited to the weak and the old, and healthy persons may take warm bath just before retiring to bed. Warm baths are the best cleansers and have a soothing or depressive effect on the nervous system. They predispose to chill. Regular use of warm bath in health increases sensibility to cold. This increased sensibility may at any time be obviated by afterwards rapidly sponging the body all over with cold water and drying the body quickly, followed by friction with a rough towel. (*c*) *Very cold baths* may be indulged in, only at times, by the very healthy and hot baths or prolonged warm baths may be taken only therapeutically. (*d*) Cold baths are unsuited to the very young, very old, the weak and those with heart disease or congestien of internal organs. (*e*) The addition of CO_2 gas or of salt to a bath has a stimulating effect on the skin. Ammonia and alkalies have a cleansing effect only.

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* *Russian bath* is a steam and the *Turkish bath* a hot-air process, both being gradually increased from 120° to even 250° F, accompanied by thorough kneading and cleaning and wound up with a plunge in cold water and rest in a cool chamber.

2. *Relation to state of body.*—When one is completely exhausted by fatigue or hunger or when one's stomach is completely empty or full, one should not bathe. Baths are meant more for those who are sedentary rather than for those who exercise vigorously and perspire freely.

3. *Duration of stay in water.*—A cold bath should be practically momentary in duration. Any cleaning process may be done before entering the water.

4. *After care.*—Immediately after a bath, the skin should be briskly rubbed with rough towel, so as to excite cutaneous hyperaemia, and quickly covered over. But in India where it is the custom to keep the body bare, except in mid winter, the risk of catching cold or of exciting nephritis or bronchitis is reduced to a minimum and the above after care may be attended to, only in winter but always by the weak.

5. *Swimming* combines pleasure with bath ; but in the rainy season as well as in winter, it is a fruitful source of diarrhoea owing to chilling the abdominal viscera.]

Personal cleanliness : (1) **Eyes**—should be kept scrupulously clean, the eyes being frequently washed in clean, cold water. (2) **Ears**—are to be cleaned whenever they become dirty. Hard cerumen inside the ears may be swabbed out with absorbent cotton, after soaking them awhile in a little glycerin and bicarbonate of soda. It is a bad habit to clean the ears with hard objects or to clean them too often. (3) **Mouth**.—Before and after each food, the mouth should be well rinsed with clean water several times. No **tooth powder**, other than magnesia or chalk, should be used in cleaning the teeth. Regular use of antiseptic tooth-powders is to be deprecated. No hard **tooth picks** are safe. The teeth should be brushed at least twice—being the first and the last acts of the day. Rubber **tooth brush** or bristle-brush of medium hardness alone should be used. **Tartar** should be removed, **caries** filled up and food debris should be removed by floss-silk carefully passed through. The use of **pan** (dressed betel leaves) is injurious to the teeth—if carried to excess or not followed by cleaning up with brush ; and the non-use of any thing like pan, arecanut, cloves, ajowan, myrobalans is a cause of caries too. (4) **Tongue**—should be only lightly scraped with a blunt metallic tongue scraper once every day. (5) **Hair** of the head should be kept short and soaped only occasionally. When necessary, oil or pomade may be rubbed in. It is necessary also to use clean brush and not too sharp comb, just to increase the circulation of the scalp but also to remove dandruff etc. **Beards** should be shaved by one's self : it is a mistake to have recourse to the barber, at any rate in India. (*6*) **All other natural orifices** of the body should be kept scrupulously clean. (7) **Nails** should be cut short and square (not round) and kept clean. (8) **Dress**—should be very clean, specially the underwears. For this purpose, it is best to use white fabrics and to avoid colours that do not show the dirt. Immediately after use, articles of dress should be well aired and sunned, and as frequently changed as one's circumstances permit. (9) **Bed clothes**—should be clean and kept clean. Mattress and pillows and quilts should be daily shaken, well aired and sunned and bed hangings should be frequently cleaned and daily aired. Eider down quilts, feather pillows etc. are not so hygienic. (10) **House, Rooms** and **Streets** in front of house should be kept clean and free from dust.

CLOTHING AND DRESS.

Their objects are—(1) To protect the body generally from injuries and external *weather conditions.* (2) To maintain it everywhere at a proper and equable *temperature.* (3) To preserve *decency* and *modesty.* (4) As a vehicle for personal *decoration.* Dress, thus, is a question of climate, civilization, convenience and habit.

Essentials of a Dress are: (1) It should preserve the natural *outlines* of the body. (2) The natural *movements* and *functions* of the body must be maintained without restriction, irritation or injury. (5) It should be capable of *distributing warmth uniformly* throughout the body. (4) It should not *irritate or injure* the skin. (5) It should be *light*, *cleanly* or capable of being cleaned, and suited to the *tastes* of the times.

Hence, in cases of children and old people, who are very susceptible to changes of temperature, a dress should be uniformly warm and should cover every exposed part of the body, or else inflammation of internal organs results. Children with bare feet or going about naked, specially during the winter or rains, are liable to have abdominal complaints. Old men with feeble circulation, easily develop bronchial troubles. In case of women, dress should not compress the waist so as to drive out of shape and position the abdominal viscera. Dresses are best suspended from the shoulders, or the waist, rather than they compress any where badly. The wearing of tight sleeves, garters, corsets, skirts, lacings, boots and neckties is responsible for weak muscles, awkward movements, misshapen thorax, waist and abdomen, varicose veins etc.

Dress Materials: Classification :—They may come :—

From animals : WOOL=the hair of sheep, goats, camels. '*Alpaca*'—is from the Peruvian sheep. '*Mohair*'—is the wool of the Angola or Angora sheep ; from it are prepared plush and braid. '*Cashmere*'—is the wool of the Tibetian goat. Camel's hair enters largely into the manufacture of *Jaegar* underclothing. FLANNEL= plain woollen stuff of a rather open and slight fabric. '*Merino*'—is wool with cotton. (2) FUR=skin of certain animals of cold countries that possess a dense hair *e.g.*, the bear, chinchilla, ermine, sable. [*Felt*=compressed fur of horses and rabbits]. (3) LEATHER—of ox, goat, horse, sheep. (4) FEATHER : chiefly used in making beds, which are generally insanitary. (5) SILK=fibre produced by the larval stage of certain moths, found chiefly in

Bengal, Assam, Madras, China etc. Satin, Velvet, Crape, Tuffety, Moire, Brocade, Ribbons and Plush are various modifications of Silk.

From Vegetables : (1) COTTON=hair of the seed of a plant of the Gossypium family (N. O., Malvaceæ). Calico, Fustian, Jean, Velveteen, Muslin, Flannelette are made up chiefly of cotton. '*Cellular cotton*' is ordinary cotton fabric with larger interspaces in its texture. (2) FLAX or LINEN=fabric made from fibres of the linseed plant. *Cambric* and *lawn* are made of flax. (3) JUTE=fibres of two plants that grow in Bengal. It is used in the adulteration of silk, in the production of certain coarse fabrics or of imitation goods. (4) HEMP=fibre from cannabis sativa. (5) COIR=fibre from husk of cocoanut. (6) INDIA RUBBER, CAOUTCHOUC or GUTTA PERCHA=juice of certain plants.

Points that render Dress materials suitable :—

(1) **Conductivity**.—Articles of clothing possess neither warmth nor coldness in themselves. On the one hand, the body is constantly producing heat and tending to lose it by perspiration ; on the other hand, the atmospheric conditions in summer are tending to heat the body and in winter to cool it. To strike a just balance between these two disturbing elements (the skin and the atmosphere), is the function of clothing : that it can do, if it is non-conducting—*i.e.*, in summer, it will not conduct the external warmth to the skin ; nor in winter, dissipate the heat of the body. Materials which are *the worst conductors* are the warmest —giving us the best protection against cold and cold winds. Arranged in the descending order of their warmth, they are :—Leather and Indiarubber, wool, fur and down, silk, cotton and linen.

(2) The degree of **porosity** affects its warmth ; for, the small interstices are filled by air, which is a bad conductor of heat. Flannel is the *most* porous, wool comes next and silk the *least*. On this principle, *loose-fitting garments* are warmer than tight ones—inasmuch as between the layers of the

former, a stratum of air is enclosed, which prevents the loss of heat from the body surface.

(3) **Hygroscopic properties.**—A hygroscopic material readily takes up the perspiration and diffuses it through its meshes. The absorbed sweat thus evaporates from the garment and not from the skin direct,—thereby preserving the latter from getting chilled. A garment with feeble hygroscopic properties is injurious to one heavily perspiring. *The difference in this respect between wool and linen* is this : The vapour, into which the perspiration is reduced, is condensed in the wool and gives out again to the body the large amount of heat which has become latent, when the water is vaporized ; but perspiration, passing through linen, evaporates from its surface without condensation, and takes away the heat. Arranged in descending order of hygroscopic properties :—Wool, fur, eider-down, silk, linen, cotton. [The same order stands for the facility with which each material *absorbs odours.*]

(4) **Colour.**—This is of importance in regard to the *external* clothing only, when (*a*) worn out-of-doors in the sun, (*b*) when it is thin, and (*c*) when it is a bad conductor and has absolutely no bearing on underwears. Since colour fails to affect in the depths of a clothing, the same material, if thin and worn over all, will absorb very different amounts of heat, when dyed with different colours. *White* and *brightly* coloured materials (grey, yellow, pink, blue, black) radiate most and absorb the least of external heat and are, therefore, suited for summer wear ; in fact, colour and thickness, rather than the texture of the material, help to protect us against heat ; *sombre* tints too absorb the most and radiate according to their conductivity—and are thus best fitted for winter wear. White clothing, in summer, prevents the passage of heat inwards ; and in winter, prevents its passage from the body. In descending order of *power of absorbing heat*, colours

are : Black, dark blue, light blue, dark green, turkey red, light green, dark yellow, pale straw, white. [Colours also help the *absorption of odours* and the order in which they do so are :—Black, blue, red, green, yellow, white.]

(5) **Property of irritating the Skin**.—To persons with delicate skin, a material with a *rough* surface will feel warmer than the same material with a smooth surface—when worn next to skin, by virtue of its roughness exciting better cutaneous circulation.

(6) **Absence of injurious properties :**—Clothes are mostly coloured by *anilin* dyes. Anilin, when absorbed by the skin, produces collapse; but when anilin is contaminated with *arsenic*, the arsenic irritates the skin.

(7) **Non-inflammability.**—In increasing order of inflammability, the dress materials are :—wool, silk, linen, cotton, flannelette. Asbestos never burns ; closely woven cloth is less inflammable than one with open meshes. 'Flannelette' was, when first introduced, very inflammable. Of late, it is being coated with a chemical which robs it of its inflammable quality to a good deal extent. But repeated washing removes the chemical coating, thereby rendering the fabric inflammable again.

Speaking generally, the best fabric for clothing is one which is a bad conductor and good absorber.

Amount of Clothing required :—This depends on—(*a*) *Health.*—The weak require more clothing than the robust whose digestion and assimilation are good. Hence, in winter, a robust, healthy man requires more food if less clothed or less food if well clothed. (*b*) *Age.*—At both the extremes, it is safer to err on the side of being over-clothed as, in the process of "hardening" children, many are sacrificed. (*c*) *Climate* and *Season*,—Be governed by the actual conditions rather than the dictates of society.

MERITS AND DEFECTS OF DRESS MATERIALS

Properties.	*Wool.*	*Flannel.*	*Silk.*	*Cotton.*	*Linen*
Heat conduction	Bad	Bad	Bad	Fair	Good
Porosity	Less	Most	Least	Less	Less
Hygroscopic properties	Very great	Good	Good	Bad	Slight
Behaviour to Skin	Slightly irritating.	Irritating	Feebly irritating.	Non-irritating	—
Fit for summer or winter. (when used alone).	Winter and Summer	Winter and Summer	Winter and Summer	Summer	Summer
Fit for outer or under-wear.	Under	Under	Under	External	External
Durability, hardness etc.	Less	Good	Less	Great	Great
Other properties	Do not retain odours. Get dirty easily	—	Light. Shrinks slightly. Costly.	Smooth, shiny unshrinkable. Don't easily absorb odours but when absorbed, odours cling.	Costly.

Wool (chiefly used as such or as flannel, merino, cashmere, puttoos etc).—If it is of close texture and kept clean by frequent washing in cold water with soft soap, it is the ideal underclothing in summer and winter, specially for the delicate and the scrofulous, the old and the rheumatic. In SUMMER it absorbs the perspiration and preserves the body from getting chilled ; in WINTER, it preserves the heat of the body and by its slightly irritating action on the skin, induces better circulation of it. Its value depends on two things : (*a*) its hygroscopic properties,—water penetrating into the fibres themselves and also lying between them ; (*b*) and its non-conductivity,—due to the presence of oil and fat and to its imprisoning air between its interstices.

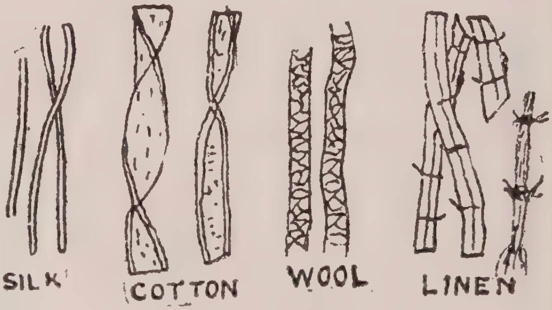
Cotton : It is a good over-wear in winter, as it keeps the underwear clean ; and, in summer, in dry heat, when one is not perspiring, cotton is good to be worn next the skin.

Linen—is mostly used for the preparation of cuffs, collars etc.

Chemical and Microscopic Properties.

COTTON. (1) Fibres are short, *twisted* at short intervals, no nodes, joints or branches. (2) H_2SO_4 gelatinizes them.

LINEN. (1) Fibres are round, broken up by nodes and joints and are composed of filaments which here and there shred off as *branches.* (2) H_2SO_4 gelantinizes it ; other strong acids or alkalies do not act.



WOOL. (1) Fibres are round, colourless, *scaly* and unbranched (*a*) Soluble in strong hot alkalii, little affected by H_2SO_4 ; $+HNO_3$=Xantho-proteic reaction.

SILK. (1) Fibres have a central tube ; they look transparent like glass. (2) Dissolved by strong acids and alkali ; picric acid stains yellow ; steeping in lead oxide does not blacken it.

Special Dresses.—

Head dress.—It is a necessity in all climates—as protection against heat or cold. The head dress should be light, have ventilation-arrangements, be capable of being cleaned, and should not sit on the forehead very tightly. It should have a broad brim to protect the neck from the sun's rays.

Socks & Stockings—should be made either of wool or of silk ; they are better if digitated and must not be tight-fitting. Stockings should be supported by means of suspenders and never by garters. They should be washed everyday.

Boots & Shoes.—Leather is better than india rubber, because the latter causes damp and sodden feet, by retaining the perspirations. Leather should be soft and pliable, the *toe end* should be broad (so as to allow free play to at least the great toe) the *heel* not higher than ¾″ and as large as the natural heel. The great toe should be parallel to the axis of the whole foot. The boot or shoe should conform to the anatomy of the foot. A shoe is better adapted to the hygiene and free movements of the ankle than a boot.

Underwear.—Wool and silk, as said before, form the best underwear. In this country, the habit exists among Indians, of keeping the doors and windows shut and the upper parts of the body uncovered in early winter ; it is much better to have doors and windows open and the body covered. Indian women too will be all the better for an underwear in the winter and in all weathers, during the menstrual period.

Children's Dress.—Besides conforming to the general rules laid down above, a child's dress should—(*a*) be *light* in weight and loose in fit ; (*b*) cover every part of the body—

not excepting the neck, arms and legs; (*c*) should have no constrictions or binders, specially at the waist, but be hung from the shoulders; (*d*) include a head cover, specially so long as their skull is thin or incompletely ossified. It is as much an error to think of hardening a child by insufficiently clothing it, as of coddling it, by swathing it in more clothes than it requires or can bear.

EXERCISE.

Definition.—*Literally*, 'Exercise' is the performance of its function by any part of the body; thus, digestion in the exercise of the stomach, respiration, of lungs &c. But, *now-a-days*, it means—contraction of voluntary muscles.

Necessity for it:—It improves general nutrition and corrects local deformities. Heart, respiration, development of brain and its powers, nervous, muscular and excretory systems—are all uniformly improved. Carriage and symmetry of the body, discipline, alertness, decision and activity are aided. The **Child's** best energy is spent in its growing body; and its natural restlessness furnishes it enough of exercise: when it has overdone its exertions and is tired, it collapses into rest and sleep and so saves itself from the evil effects of overexertion. A **Woman's** body has, in addition, to minister to the growth of her sexual organs as well as to the growth of her child. But not so in the case of an **Adult man** in whom exercise is necessary to wear off old tissues and to replace them by new and increased tissue. A machine is worn down by exercise, but exercise in men (who possess the powers of self-renewal) creates a demand for more oxygen and better oxidation of his old tissues and of food. If regularly and judiciously performed, it leads to harmonious and increased functional activity of all organs of the body and to its gradual development. Exercises are useful as a means of—(*a*)

Developing the weakly and the overgrown. (*b*) Hastening *convalescence*—generally (as after an illness) or locally (as after an injury). (*c*) Correcting *deformities*—of chest, spine, shoulders &c. (*d*) *Relieving*—general conditions (like obesity, debility &c.) or local conditions (like emphysema, chronic constipation). (*e*) *Educating*,—imparting physical tone to the body of those who cannot or will not do so normally; mental training to the mentally deficient; and moral tone—by inculcating courage, self-restraint, control of temper, and obedience to discipline.

Effects of Exercise—Exercise equilibrates the muscular and nervous functions, increases the working power of the muscles, helps to burn up effete tissues and to wash away the products of combustion and by carrying increased blood (bearing renewing materials) it helps development. The effects of—

Healthy or Physiological.	*Excessive Exercise.*
Muscles—increase in volume, density and energy	*Muscles*—are exhausted and wasted—with less oxygen and more of waste products in them. If chronically induced, muscles are wasted.
Lungs—(1) Amount of air inspired is increased[*] (2) Increased C_2O + and H_2O given off. (3) Size and vital capacity of lungs are increased.[†]	*Lungs.*—Laborious or impeded breathing (∴ congestion of veins and lividity of face).

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[*] If the **amount of air inspired** while **lying down** = 1, then the amount of air inspired when one is **erect** is 1·33; when **walking** at the rate of 1 mile an hour, 1·9; at 4 miles per hour, 5; at 6 miles per hour, 7; **riding** on horse back, 4·05; **swimming** 4·33.

[†] **Amount of CO_2** expired bearing a constant relation to the amount of muscular exercise, affords a just estimate of their value. If the CO_2 given off is rapidly removed by good **ventilation**, muscular exertions can go on; if the room is ill-ventilated, activity diminishes. **Alcohol** decreases CO_2 excretion and should therefore be avoided during exertion. Rather take **sugar**.

Skin : * Insensible perspiration is always increased but sensible perspiration is increased only until the individual becomes habituated to hard exercise.

Temperature †—is not increased but tends to be equalized throughout the body.

Heart : Force and frequency of beats is increased regularly and equally.‡

Circulation—Bettered and equalized throughout the body.

Digestion : § (Effect is greater if taken in *open* air). Thirst is created. Appetite is increased especially for salts fatty and proteid foods. Digestion is more perfect, absorption more rapid.

Intellect—is made active.

Urine : - urea || is slightly increased ; uric acid is increased ; chlorides and water decreased.

Heart :—Action becomes quick, weak, unequal and irregular (if prolonged and severe) ; palpitation, valvular lesion or dilatation (after sudden, hard, long continued exercising).

Constipation :—occur from loss of too much fluids by perspiration.

Intellect.—Fatigued, specially in the young, the weak and the invalid.¶

Sexual.—Testicular secretions are diminished ∴ decreased sexual appetite.

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* **Danger of catching chill** is less *during* exertion (when the skin is kept continuously supplied by warm blood) but increases *after* exertion.

† **Temperature** is not increased on account of loss of CO_2 and H_2O by lungs and skin.

‡ **Intellectual labour** involves waste of body just as much as physical exercise does ; severe exertions of both simultaneously (as done by students when examination is at hand) is injurious.

§ Effect of exercise on digestion and appetite is greater if taken in **open** air.

|| This proves that exercise does not oxidise **nitrogenous** substances of muscles only but also other oxidisable and **non**-nitrogenous substances. Increase of **urea** elimination occurs in the period of rest succeeding exercise.

¶ Hence persons with **diseased hearts** or with inelastic arteries (old age) should avoid sudden, violent exertions.

Effects of Over-Exertion :—(A) **Immediate :** (1) A general falling off in bodily *tone* and *vigour.* (2) Possibility of rupture of *muscle*-fibres. (3) Possibility of rupture of a *blood vessel* in brain, lung or eye. (4) Dilatation of *heart.* (5) Valvular yielding in the heart. (6) Catching *cold,* if ill-clad. (7) *Abdominal* troubles (hernia, volvulus &c.)

(B) **Remote** : (1) Arrest of *growth* and *development* of body—in youngmen. (2) Lighting up of *dormant diseases* like—scrofula or consumption. (3) *Kidney* is likely to become diseased. (4) Permanent injury to *joints.* (5) *Spinal* curvature in women. (6) Varicose *veins.*

Effects of Deficient Exercise : Pale wan *appearance,* bad *complexion,* foul *breath* ; *muscles* waste and become sluggish ; *adiposity* increases ; *temperature* is not uniformly distributed throughout body ; *heart* is enfeebled, *circulation* less perfect, *digestion, appetite* and *assimilation* impaired, *nervous system* becomes irritable, brain weary and sleep decreases. Modern conditions of incessant work in crowded, smoky cities, with all the laws of health set at naught, make exercise a greater necessity.

Rules for Exercise :—Avoid :—(*a*) Exercise by *boys* or *old men* with atheromatous arteries or *heart diseases.* (*b*) Exercise without previous and subsequent regular *medical examinations.* (*c*) *Sudden, violent* exercises, specially those involving strain of the chest and abdomen for prolonged periods. (*d*) Exercise on empty or completely full *stomach.* (*e*) *Overdoing** your part : stop just when your body feels buoyant and exhilerated. (*f*) *Holding your breath* or bracing your *waist tightly* during exercise.

After finishing exercise—Avoid (i) *Chilling* yourself by trying to cool quickly ; if you are perspiring much, scrub your body with a rough towel, cover your chest and slowly walk up and down to cool. (ii) Never *drink cold water* till you are cooled thoroughly. (iii) *Sitting crooked* or in cramped postures —but sit bolt upright. (iv) Heavy smoking.

Exercise **should be**—(*a*) Taken *systematically* and *regularly* under expert guidance and medical examination. (*b*) Directed towards developing *equally every part* of the body and not one part of it. Foot ball develops the legs, rowing and gymnastics the trunk and arms ; but lawn tennis and well regulated dumbbell and other exercises develop the whole body. (*c*) Taken only in the *open air*.

When well cooled, exercise should be **followed by**—

(*a*) A regular *sponging* of the body,—so as to remove the epithelial debris from the skin. If these are not so removed, they increase the moisture of the skin and predispose to chills. (*b*) A diet richer in hydrocarbons and proteids than in carbohydrates. (*c*) Long periods of *rest* in *easy* positions.

Amount of Exercise necessary.—For a man of average weight and height, a fair day's work is 300 foot-tons. The equivalent of 300 foot-tons of work is a 17 miles walk on level ground, at the rate of 3 miles an hour. But, the heart and other organs of our body between them do 260 foot-tons a day,—leaving a demand for 1/7th of all the force obtainable for the food consumed. These theoretical considerations apart, the amount of exercise to be undergone by an individual should be fixed after due medical examination of each case individually—before and in the course of training. For a man going up a height, the formula for calculation of work done is :—

$$\left\{\begin{matrix}\text{Weight of}\\ \text{the person}\\ \text{(in ℔)}\end{matrix} + \begin{matrix}\text{weight carried}\\ \text{(in ℔)}\end{matrix}\right\} \times \begin{matrix}\text{distance walk-}\\ \text{ed in feet}\end{matrix} \times \begin{matrix}\text{feet in}\\ \text{miles}\end{matrix} \times \begin{matrix}\text{coefficient}\\ \text{of traction.}\end{matrix}$$

$$\div\ 2240\ \text{℔ (or 1 ton).}$$

[*Coefficient of traction* is the fraction expressing the resistance due to traction ; it varies with the velocity at which the work is done—being 1/38 for a velocity of 1 mile an hour, 1/26 for 2 miles per hour, 1/20 for 3 miles an hour 1/16 for 4 miles per hour etc].

Forms of Exercise.—Exercise should be combined with amusement as far as possible—*i.e.*, it should be truly *recreative* (like out-of-door games, rowing, etc.). But, for purposes of developing the whole body, systematic *educational* exercises should be gone through under special instructors; while, for getting over local defects or deformities, *specially-devised courses* should be gone through (such as the Swedish exercises, the Schott treatment, singing, speaking or reading aloud, vocal music, deep breathing, etc.)

Rest and Sleep.

Necessity for Rest.—Rest which literally *recreates*—is essential to the body and specially to the brain. Sleep, the most intense form of rest, serves the three-fold purposes of —(*a*) *removing*, all the better, the products of functional activity (by the blood) to the excretory organs; (*b*) *repairing* waste—by bringing fresh nutritive material to the tissues; and (*c*) *storing up* tissue-food—brought by the blood and some amount of reserve force.

Nerves of special as well as general sensation get fatigued after prolonged exercise (stimulation) and are not recouperated until after rest. The brain gets fatigued after prolonged activity and recovers after a much longer period of rest than that required for muscles.

Nature of rest.—Complete inactivity, so far as that is possible, is rest. But though this may be applicable to the body generally, in the case of certain organs, only *partial* rest is possible and oftentimes, a change of occupation affords rest to a fatigued organ. Thus, after a spell of study, a walk, or a little music or gymnastic exercises or even reading of light-literature may be restful. While, even during the profoundest sleep—the *heart* works (resting $\frac{6}{11}$th of a second, each second, it rests 13 out of 24 hours), the *respiratory* *muscles* work (resting only 3 hours out of 24), the *spinal cord* and *sympathetic system* are wide awake, and the *alimentary* and *excretory* organs are awake too.

Sleep : **What it is**—we know not. It is not really due to any of those various suggested causes :—cerebral anaemia, action of thyroid gland, of arachnoid plexus, or of basal ganglia, accumulation of lymph in the lymphatic spaces round the cerebral vessels ; chemical changes in the neurons. **Its onset** : Commencing with rest of muscles, it is followed by closure of eyes (due to muscular rest) and wandering of thoughts ; hearing goes out last. **Functional activities during sleep** : *Decrease* occurs in regard to the actions of—Respiration (which, together with the amount of inspired air and CO_2-output falls), heart, blood-pressure, temperature (owing to diminished combustion) and of viscera generally. *Increase* occurs in respect of—absorption of oxygen, venous engorgement of limbs, activity of sweat glands (∴ greater liability to chill during sleep) assimilation (∴liability to greater absorption of noxious gases, if any).

HABITUAL DEFICIENCY OF SLEEP—leads to wretchedness, prostration and restlessness and even insomnia. HABITUAL EXCESS OF SLEEP—leads to torpidity of brain functions—persistent deficiency as well as excess both lead to degeneration of brain.

Rules Regarding Sleep.—AMOUNT REQUIRED : Sleep should vary with :—(*a*) *Age.*—It is in babyhood and old age (*i.e.*, during the formative, rather than the functionally active, stages of the nerve centres) that greater amount of sleep is necessary. An infant sleeps 16 or more hours out of 24 ; small children should sleep 12 hours, young lads and girls 9 to 11 hours, adults 7 hours. An old man should spend 10 to 12 hours in bed (sleeping or not). Children do not require to increase their amount of sleep when they begin lessons. (*b*) *Tempera-*

ment :—Nervous children ought to sleep a little longer ; so too adults of cold, lymphatic temperament. (*c*) *Sex.*—Women require comparatively a slightly longer period of rest. (*d*) The *Sick* and *Convalescent*—whether from disease or from such a natural process as delivery, require greater rest. (*e*) *Occupation.*—Brain-workers require more sleep than do muscle-workers. (*f*) *Times of Meal and Study.*—After a good meal, "rest" for at least two hours is essential ; but none should "sleep" within two hours of a full meal. There should be at least an hour's interval between study and sleep.

2. (1) Sleep *on beds* and *on bedsteads* and never cover up the head. The expired CO_2 being heavier, lies near the ground and those sleeping on the floor or on beds on the ground, reinhale their exhaled CO_2 and other noxious gases, and the circulation of air under and around them is impeded. (2) Beds should be *clean* and *fresh*—as, otherwise, the waste matters from the person of the sleeper stick to them and cause ill-health. (3) Have plenty of *fresh air*, but avoid direct draughts. (4) It is better to avoid sleeping on the back or in a curled up *posture* ; the head should be always on a higher level than the body. (5) It is best to have for each one a *separate bed* and overcrowding in a room is to be avoided.

(*b*) MIDDAY SLEEP.—In the hot weather, in the tropics, every one is the better for a short rest in the midday. Children under three should be compulsorily sent to sleep, adult women are the better for it and people over 50 should spend at least three hours in the horizontal posture.

CHAPTER XXII.

SCHOOL HYGIENE.

Object: (1) The child of to-day will be the citizen of tomorrow. As such, it is, in the long run, economical to the State to see that children grow up into healthy manhood, avoiding preventable diseases, overcoming curable weaknesses and deformities and not unduly developing one part of the body to the exclusion or detriment of the rest. (2) Education no longer assumes that every child is normal and can go through a uniform course ; it now seeks to adapt the education to the child—*i.e*, to develop the parts a child possesses, along lines most conducive and natural to the learner. Thus, instead of encouraging the partially deaf or lame pupils, with defective vision, to compete for the arts or science courses, they are taught some profession or other branches of learning to which their physical developments best adapt them. The feeble-minded are no longer thrown into the company of bright boys, to be always neglected or taunted. The scrofulous children are not shut up in the close atmosphere of the class room but are taught in open-air classes. (3) To help us therefore to *find out* wherein lies the defects, in our pupils and to enable the guardians of pupils to know and *follow up* those defects with a view to their removal or correction, is the object with which School boys' health should be examined. (4) To exclude children too weak to be at school.

The Movement: This world-movement towards personal hygiene of school boys commenced in Wiesbaden, Nuremberg etc. in Germany, where in 1898, it was adopted throughout the towns. Switzerland, France, Austria, America (North and South), Japan, (1898) and Great Britain (1907) followed quickly. In India, in 1913, the Government of India recognized the necessity for the examinations and in 1915, the Punjab Government, in 1916 the Burma and Madras Governments, and in 1911 the Bombay Government commenced work. The United Provinces and Bengal remained inactive, beyond carrying on certain academic conferences. In July, 1916, I commenced amateur work in Calcutta, just only to call public attention. In Europe they held in 1904, 1907 and 1910 three International Congresses on School Hygiene and 1917 Baltimore is going to have a National School of Hygiene.

Details of Examination : For examination of School-BOYS' health to be effective, it must be conducted by regularly organized staff, be *periodical*, *regular*, *systematic* and *thorough*. It should be also *progressive* ; that is to say, a student's complaints and shortcomings should be systematically followed, along with his progress from class to class. *Sympathetic co-operation* is essential between the guardian at home and the teachers at school, both of whom should be present and participate in the examinations. The defects in the school BUILDINGS and rooms should call for equal amount of attention with similar defects in the HOME and its surroundings. The parent at home should not be taxed or harassed by the medical examiner or by the local government, to undertake expensive hygienic measures ; on the contrary, where necessary, FREE SUPPLY of *treatment*, free tickets for railway or boat *excursions*, free *visits* to the students' home in illness, free *tiffin* should form an integral part of the school-boys' health concern. Whenever a poor child is ill, he should be treated free or admitted into a hospital ; but, in a hospital, a child should never be longer than it takes to cure his acute illness. His convalescence at home should be carefully followed by the medical officer. A broad study should also be made of the *social conditions* that make for sickness and disability. Examination along these lines should be confined to :—

(A) **The Boy's Home and its Surroundings.**—School hygiene cannot be divorced from home hygiene ; therefore, examine the general sanitation ; and examine in particular—(*a*) the *sleeping* room, (their number ?) and the number of persons in the family, the *study*, (which must be at least 6ft. × 4ft). Are these combined in one ? Note if the *beddings* and *clothes* are clean, and free from vermins. Note the *posture* adopted by the boy while reading, the distance at which he holds his book, the amount and direction of *sunlight* and the nature, position and amount of the night illuminant. Note if there be any of these *bad habits*—spitting on walls or floors, cleaning slate with saliva or moistening finger with saliva, biting nails, picking at the ears or nose, want of regular cleaning of teeth and mouth. Examine the *sanitary installations.* Note the physical condition of *parents* and of *brothers* and *sisters*, the *care* that the children get at home, the *food* the children get (quality and quantity) and the manner in which food is kept, prepared, handled or served ; the amount of *open space* and the manner in which children utilize it. Enquire the length of time the child is *out-of-doors*.

(B) **The School Building** should conform to these regulations :—

Site.—The school should occupy a site that is *central*, has *facilities of access* by the scholars, is *quiet* (*i.e.*, free from noise of passing vehicles, workshops &c.), is *austless* and can command extensive *open grounds.* If possible, it should be on the top of a hill, facing south, on a gravelley, chalky or sandy soil, protected from north and east by tall trees. Its surroundings must be free from tall houses and from offensive odours.

The area should average ¼ acre for every 250 scholars.

Building.—If it is on a high road, it should be *set back* at least 60 ft. The building should not be cut up into classes but rather classes should be laid down according to some definite plan. The corridor or hall plan is better than the one with a central hall. Corridor should be at least 10 ft. wide. *Storey.*—Not more than two storys are desirable.

If a *central hall* is wanted, it should be of such size as to give a floor-space of 4 sq. ft. per scholar and it should be separated from class rooms by ventilated corridors. *Light.*—Angle of incidence of light should not be less than 25° and the angle of aperture never less than 5° of an arc in any part of the room. Avoid glare—if necessary, shade the outside of windows to cut off sunshine ; never have windows full in the face of the scholars. Secure light from every part of each room sufficient even on dull days ; if necessary, use prism panes and reflectors. Seats should be so arranged that the prominent light falls on the scholar's left. Avoid direct sunlight into any room. [Artificial illumination :—If gas light is used, its globes should be glazed (to absorb excess of ultraviolet rays) and inverted incandescent burners should be employed. If electric light is used, employ inverted lamps. These lights should be situated 6ft. from floor and 6 ft. apart—the first light being placed a little to the left of the first seat in the first row facing the teacher. The lights should be 10 to 15 candle metres on desk—*i.e.*, at one metre distance should be 10 to 15 c.p]. *Windows*—should be at least $\frac{1}{10}$th and should not exceed ¼th of the floor area of the room, reach as high as the ceiling, open directly into the external air, have as little intervals between them as possible and their sills should be at least 4 ft. high from the floor. *Width of rooms* should not be greater than 2½ times the height of the window heads from floor. *Ventilation* (in cold countries) : 150 cft. of space, 15 sq. ft. floor space (or, in this country, a minimum of 9 sq. ft. or 90 c. ft.) and 1500 to 2000 cft. of fresh air per hour per scholar will ensure the minimum of draught commensurate with ventilation. Try to keep the dry bulb temperature of the classes between 56°F and 60°F and the wet bulb temperature between 53°F and 56°F. *Warming* (in cold countries) : A temperature of 65°F in the infant classes and 56° to 60°F for older children must be maintained by one of these : low-pressure hot-water system (12 to 16ft. piping for every 1000 cft air), ventilating fire grates, a fire place with a boiler immediately behind it or slow-combustion stoves. [Keep a thermometer, away from the fire and at breathing level, in every class]. *Walls*—should be painted or distempered (to admit of washing), only pale and subdued colours (*e.g.*, soft-greenish gray) being used. Avoid cornices and projections that can harbour dust. *Floor*—cemented or paved with glazed tile or with hard wood (beeswaxed). It should be swept daily. *Seats*—should be arranged so that from each seat the sky can be seen and be parallel with one another (24 in. from walls and 10 in. from each other) and at right angles with the windows, and scholars sit with the left hand nearest the main window. Seats and desks are to be adjusted to the scholars twice yearly. Width = 24 in. Girls grow most between 12 and 14 and boys between 14 and 16. There should be a straight-back to the seat, with curved pads to support the small of the back and loins to the level of the shoulder blades. Separate desked seats are extravagant. *Desk* should be: Sloped at an angle of 15° for writing and 45° for reading; 15 to 18 in. broad; in height, above the seat = ⅙th scholar's height; its distance from seat should not exceed 1". *Blackboards* should not be shiny nor be set between two windows.

PLAY GROUND: *Open* drill and play ground and gymnasium as well as *covered* sheds as play ground (to be used during rains), must be liberally provided. A suitable number of apparatuses for the purpose must also be provided.

SANITARY CONVENIENCES (urinals, lavatories, water closets) must be provided and kept clean—to the number of 1 for every 20 grown boy and 1 for every 15 pupils of the infant class. They must be periodically disinfected and regularly flushed. Lavatory basins must be also provided where every pupil that comes to school unclean will be *compulsorily* cleaned up, as an object lesson in sanitation.

DRINKING WATER: In several schools, the custom is to utilize a dark, ill-ventilated ground floor room, perhaps under the stairs or near the places of conveniences, for storing water in large earthen vessels—drinking pots or cups being left about on the floor or on a rotten wooden rack. This should be abolished. Closed vessels with screwed taps or "Crystal Stream" drinking fountains should be substituted. If drinking cups are used, they must be daily cleaned up and continually exposed to flowing water, during play hours. The most rigorous measures should be taken to exclude food hawkers, ice-cream sellers and other purveyors who sell poison in the guise of edibles. Nor should children be allowed to scale the fences to enjoy a secret smoke or secure edibles of bad quality from outside. Wholesome tiffin should come from home or from school to every scholar, rich or poor.

Dust and dirt are to be kept out by means of (*a*) insisting on boots and dress being clean, (*b*) door mattress being of steel wire

c) chalk troughs being attached to black boards, (*d*) avoiding decorations on walls, (*e*) periodical dusting of maps, books, shelves, almirahs, cupboards, (*f*) weekly scrubbing up of wood works, floors, desks, seats, platforms, window sills etc. with a liberal supply of hot water and soap, followed by a disinfectant. (*g*) All waste matters are to be promptly burnt or deposited in covered bins.

DORMITORIES—must face south, if possible ; be well lighted and ventilated (windows going well to the top of the room) ; should have an average temperature of 55° to 60°F ; and at least 400 to 500 cft. of space must be allowed for each scholar under 12 years. In sleeping rooms, in winter, 800 cub. ft of space must be allotted to each boy ; in hot weather, less may be allowed. Dormitories should never be used as places for study. Cubicles must be studiously avoided as fostering bad habits in secret.

(C) Examination of the School Boy.—This should be done in the case of *every new admission* ; thereafter, *twice a year* or oftener, in the case of *defective or diseased scholars* ; and *daily*, during outbreaks of *infectious diseases*. The result of examination must be put down legibly and carefully in ink on printed cards, in the presence, if possible, of the guardians and of the teacher. The cards must be carefully preserved and copy of them should be given to the scholar on his leaving the school on transfer. Any serious defect or disease noticed must be forthwith brought to the notice of the guardian for treatment at home or in a hospital, for which latter purpose, a free ticket should be provided by the headmaster.

INSTRUMENTS REQUIRED : (1) A portable weighing machine. (2) A height measure, marked off in feet and inches, with a sliding head-rod. (3) A measuring tape. (4) A tongue depressor. (5) Stethoscope. (6) Tuning fork. (7) A watch. (8) A reflecting head-mirror. (9) A tray with some lotion, to keep the tongue-depressor in. (10) Snellen test types, with a sunrise dial. (11) A table with a clean pillow.

ASSISTANTS &c. REQUIRED.—(1) There ought to be one clerk and a peon to help generally. (2) A separate funished office,—well lighted, free from noise and at least 25 feet long.

The Examination Form :—

I. IDENTITY

Name. Nationality. Address. Date of Birth (1)
School. Class. Section.

II. FAMILY HISTORY.

Father's occupation. Income. Number of Brothers and Sisters (living). Causes of death (if occurred) of Father, Mother, Brother, Sister individually (2).

III. PERSONAL HISTORY.

Place of Birth. Does he regularly visit or live in his village home? Total duration of stay in town? What have been the serious ailments since birth and at what ages (3)? Any illness during this year? Is he frequently ailing? What with? Was he vaccinated? At what ages? Does he use spectacles, ear drums, crutches &c? If so, from what age? Does he maintain himself by 'private tuition' of pupils? Is he a free scholar?

Does he *regularly* eat—(*a*) Fish, (*b*) Meat, (*c*) Milk, (*a*) Ghee (with rice), (*e*) Poories or loochies? Does he regularly take tiffin at school? What is his food at night (rice or chapatees)?

What are his *amusements*? Does he regularly take any kind of *Exercise* (dumbells, gymnasium, clubs, wrestling, swimming &c.) or play games (football, tennis &c)? Specify which and the hours.

Does he live with guardians? or in a boarding? Is it licensed?

What is the total number of *hours of study* at home (by day and by night)?

IV. MEDICAL EXAMINATION.

Age of the pupil (physical and psychical). Height (4). Weight. Physique (5). Appearance. (6) Measurements of—chest girth, chest expansion, cranium (above supraorbital ridge) and of abdomen (at level of navel). Cleanliness—of head, of body, of dress, of habits. Teeth. Nose. (7) Throat. Tonsils. Tongue. (8) External Eye diseases. Pupils. Eye sight (9)—right, left. Ears (right, left).

Hearing. (10) Dress—is it sufficient? Speech (9). Heart. Lungs. Spleen. Liver. Nervous System (11).

DEFORMITIES: Are there rickets, spinal curvature, talipes, squint, club foot, harelip, deformed chest, shortened limbs, stunted growth, mis-shapen head, hernia &c?

DIRECTIONS: [Items I, II. and III must be filled up at home by the guardian or, if the pupil is a boarder, at the school boarding, by the officer in charge—previous to actual medical examination. No examination should be undertaken unless the form is filled up satisfactorily] (1) Birth date must be exact. (2) Enquire specially about death from phthisis. (3) Diphtheria, phthisis, malaria, kidney diseases, small pox, enteric, measles, whooping cough, scarlatina, meningitis, mumps, rheumatism, syphilis should be specially enquired into. (4) To be taken without boots, standing erect, with feet together and the weight thrown on heels and not on toes or outside of feet. Growth in height, without a corresponding increase in weight, demands attention. (5) Muscular development. (6) Pale or florid, obese, thin or wiry. (7) Note if any obstruction polypi or discharges are present. Note if pupil is a mouth breather. (8) Omit vision in children under six years. (9) Note if stammering, lisping &c are present. (10) Apply tests in a general way to children under six. (11) Including chorea, epilepsy, paralyses, nervous strains and disorders.

Notes upon the School Child—An intelligent teacher is a great asset to a school. He should not only teach the lessons but also teach his pupils to become *men*. He should, therefore, know the lines along which to study his pupils and should keep watch and ward over them. To help the teacher, we give the common physiological and pathological entities of a school boy:—

I. NERVOUS SYSTEM: The nervous system of a child between 3 and 10 years gets easily tired. Up to 5 years of age, a child should be educated through the senses and after 10, his reasoning powers and imagination may be developed. The chief period of character formation is from 5 to 8. As a boy goes to school to prepare himself for his contact with the world as a reasonable being and not as a skilled classic scholar, his *tastes* and *capabilities* must be specially studied by the guardian and the teacher. A school boy should *sleep* as follows : Age between 4 to 8 years – sleep 12 hours ; 9 to 12 years, 11 hours ; 12 to 14 years, 9 to 10 hours ; 14 to 20 years, 9 hours. While taking his class, breakdown or defects of this system should be anxiously watched by the teacher, so as to give timely relief to the pupil. The following are some of the commonest defects :—

(1) FATIGUE OF MIND : Work in wrong way and time and of a wrong nature causes fatigue quicker than actual overwork. The fatigue is measured by the ergograph or the aesthesiometer. In this condition, pulse and blood pressure are increased, cutaneous sensibility lessened and muscular force depressed.

(2) FATIGUE OF BRAIN (or Overpressure) : (*a*) *When transient*, overpressure is attended with yawning, lassitude, drowsiness ; fidgetiness ; wandering eyes, faulty response to words of command, inattention ; impaired head-balance ; little or purposeless movements. (*b*) *When continued or abnormal* : (i) Irregular muscular movements—of fingers, eyes and mouth ; defective balance of the body (specially head) ; (ii) excessive reflexes – stuttering, restlessness, irritability, grumbling, excessive sensitiveness to reproof ; (iii) impaired delicacy of touch perception ; (iv) langour, listlessness, headache ; (v) wakefulness, night terrors, somnambulism ; (vi) poor appetite, digestion and circulation and pallor of body.

(3) APPARENT DULNESS—of a scholar—may not be in all cases due to stupidity but to defective hearing, sight, and nourishment ; to bad ventilation, insufficient sleep and recreation. As soon as this occurs, the child should be ordered rest, pure air and good, nourishing food and his dulness will disappear.

(4) MENTALLY DEFECTIVE (This does not refer to those who are dull and backward). It includes those suffering from word-blindness, word deafness, moral imbecility. They should have special classes held for them.

(5) DULL & BACKWARD : They should not join ordinary schools but schools where manual training under continuous personal observation can be given them.

Remedies (See Exercise, p. 318) : Whenever the teacher suspects over-pressure, the *Lessons* given must be shortened, classes must be made and kept quiet. [The number of hours a boy should *ordinarily* work per week is—for ages 7 to 8 years, 12 ; 8 to 10, 18 ; 10 to 13, 24 ; 13 to 15, 30 ; 15 to 17, 36 ; and 17 to 19, 42 hours. Ordinarily, too, each school 'period' should never exceed 45 minutes ; each period is to be followed by 10 minutes' interval, besides a half an hour's leave must be given for *tiffin* and *recreation*, when each scholar must be encouraged to eat something and to play in the open ; the subjects must be varied and in proper sequence. *Home lessons* are to be given after 10th year and to be confined to revision work and not to occupy more than an hour.]

II. Vision : The child's eye is developing and gets easily tired. Its eyes are relatively short from before backwards (*i.e.*, is hypermetropic). If taught too early to read, it has to strain its eyes, which produces fatigue of eyes and brain. *To obviate all these*, insist on the following : (1) Books are to be printed with clean-cut, thick-faced, double pica type for infants and "pica leaded" for older school children—in both cases, with sufficient space between words and lines. (2) Books are not to be printed on thin, glazed or very white paper. (3) Printed books must be held at least 12 inches and handwritten books, 14 to 16 inches away from eyes, the scholar sitting erect. (4) Light should fall from behind and on the left and the scholar should not sit facing a glare. *Detect Defective Vision*—when the child gets fulness of head, frontal headache (which gets worse at night but is relieved by sleep), redness of the eyeballs and eyelids, watering of the eyes, blinking, dizziness, nausea, irritability. *Suspect Short Sight*—when he partially closes the eyes when looking at distant objects, when he holds books within 12 inches of his eyes, and when the eyes are prominent and the pupils are large. *Suspect Long Sight*—when fhe eyes are small, deep-set, watery and red, and pupils are contracted and there is convergent squint. *Suspect Astigmatism*—when the child peers or looks obliquely at objects. *Colour Blindness*—is tested by means of a few skeins of bright green wool, mixed with a mass of confusion colours, among which reds figure prominently. If the child can pick out all the skeins that match a pale green skein, he has no colour blindness—for, colour-blind people cannot tell red from green. *Word Blindness* (*i.e.*, want of memory for words or letters) is congenital and hampers the progress of the child. No defect of vision should be neglected. Children with defective eye sight should be supplied a pair of spectacles gratis (if their guardians cannot afford it), should be allowed, in the class room, to sit in places comfortable to their sight ; should be annually examined as to their vision and when they leave school, should be provided with a note as to their vision, on their health cards.

III. DEFECTIVE HEARING.—*Sufferers give history of* adenoids, enlarged tonsils, middle ear diseases, diseases of nose and throat. *Test defect* by—whispering, stop-watch, tuning fork, audiometer, acumeter etc. *Suspect defect*—if the child is apparently inattentive, or stupid, if he misses spoken words, if his attention is strained (and therefore, he gets easily exhausted from lessons), if he is a mouth-breather and complains of earache, headache, giddiness, discharge from ear, etc. *Treatment.*— Let the pupil occupy always the front seat and speak to him distinctly and loudly. A note of the defect should always be made on his ticket and the causes of his defective hearing must be removed where that is possible.

IV. RESPIRATORY SYSTEM : *Suspect defect*—if the child is a mouth breather, has muffled nasal voice, vacant, unintelligent expression, pigeon-breast, mental dulness. *Insist on* regular nasal breathing and deep-breathing exercises treatment of nasal defects etc. and fresh air excursions.

V. CIRCULATORY SYSTEM : *Suspect defeet or disease*— if the scholar is pale, liable to faintness, cyanosis, palpitation and pain over region of heart, coldness of extremities. *Treatment.* Reduce their mental work ; give deep breathing and other graduated exercises under medical care.

VI. ENLARGED GLANDS—may be the result of—pediculi, wounds, sores and eruptions on skin or scalp, throat or ear trouble, carious teeth, scrofula or struma. Either the presence of adenoid growths or enlarged tonsils tends to produce mental defect or backwardness in school, or, the conditions that favour the growth of adenoids bring about a lowering of mental capacity. The causes should if possible be removed and scrofulous children should be specially attended to.

VII. SKIN.—The habits formed at school remain all through one's life. It is imperatively necessary, therefore, to insist on cleanliness at all costs. A pupil should be compelled to put on fresh clean clothes every Monday (care being taken to see specially if the under-clothings are at the same time, clean or not) ; uncleanliness of clothes should be punishable. Every boy should be carefully examined as often as possible for clean conditions of head, face, hands and feet and finger nails (which must be kept short). Any student found unclean should be promptly washed in the school, to the satisfaction of the teacher. Children should be taught that it is unhygienic to slip into the same bathing tub or chowbachha one after the other or several together. The following skin-diseases are common among school boys : (1) *Pediculus capitis* : This is a disease of dirty heads, being caused by the louse (pediculus) or their eggs (nits). The females of this greyish white insect suck blood after biting—hence the itchiness of the scalp. Look for the nits on forehead or behind the ears, half an inch from the scalp. To get rid of them, soak the hair overnight with carbolic or paraffin oil, wash next day with soft soap and water and thereafter comb the hair with toothed comb, dipped repeatedly in vinegar. Repeat this for some days. (2) *Ringworm* : This also is caused by a parasite which is difficult to eradicate thoroughly. Caps should never be exchanged and pupils suffering from it should be kept in a separate class by themselves. (3) *Impetigo contagiosum* —occurs usually on face, scalp, hand and arms. It spreads easily. (4) *Favus* (5) *Scabies* and *Itch.*

IX. DIGESTIVE SYSTEM : Foul flabby, tongue, foetid odour in mouth, unclean and carious teeth, tender or enlarged liver point to digestive troubles. Dyspepsia, constipation, or irregular evacuations are the symptoms. Strict attention to quantity, quality and times of eating, oral toilette, and attention to faulty teeth are essential.

Exercises : A boy is an active animal and unless kept employed at an innocent and healthy occupation, will take up something that is not innocent : Indeed, the idle boy who won't play is the bane of every school. Unless a boy has phthisical history, or has mitral disease or had serious illness recently, make attendance at one of these *compulsory* :—Foot ball, paperchases, cricket, boating, racquets, fives, lawn-tennis, swimming bath, boating, bicycle riding, gymnasium. Delicate boys must join one of these : gardening, carpentry, music, art, drawing, field excursions in botany, natural history and geology. No boy should exercise, unless dressed in flannel, (summer and winter) and a boy who is too lazy to change wet clothes after exercise should be punished. Exercise should commence at the 8th year, with organized *games* and *drills*. After 14, begin the *gymnasium* exercises and go through them for short periods everyday. Ling's Swedish system and Folk-dances are both excellent. Sickly and deformed children, convalescents from diphtheria etc., those who have walked long distances to school, those aged between 13 and 16, the rapidly growing and overgrown children—must be excused only the *exacting* exercises.

Punishments.—A growing boy, like a growing tree, requires plenty of air and light. Hence, it is much better to birch him than to confine him or set him lines to write or memorise. It is sometimes wrong to flog and often wrong to withhold it when deserved. No child must be caned on the buttocks. Wholesome satire is perhaps the greatest punishment for a boy. If a change of teacher does not cure him, expel him.

Posture : Ossification of the body is practically complete by 12th year of age ; before this period, those who are rickety strumous, debilitated or overgrown, develop faulty postures ; and with them, deformities like—round shoulders, spinal curvature, myopia etc. These are brought about by—*seats* being too high or too low (hence, the seat and desk should be adjusted to each scholar at least twice a year), too narrow or too flat and have no spinal support ; *desks* are too high or too low, and too narrow, with faulty slopes; faulty school *programme*, small *prints*, bad *lighting* of class-rooms etc.

Dress—of children must be loose and light. Heavy ill-fitting boots, tight collars or neck-ties, garters, stays, bodices, belt and braces are best avoided. See if the dress is *sufficient.*

Food: Girls between 10 and 14 and boys between 14 and 20 require more food, as per table below (water-free calculation) :—

	Seven years.	*Ten years.*	*Fourteen years.*
	oz	oz	oz
Proteids	2·0	2·5	3·0
Fats	2·3	3·0	3·5
Carbohydrates	8·0	10·7	12·7
Minerals	0·7	0·8	0·8
	13·3	17·0	20·0

Grown boys should eat *whole-meal* (not bran) bread, and the crust of all breads. *Milk* and *sugar* should never be stinted. For those used to it, 1 ℔ of uncooked *meat* must be given at least once a day. Bolting of meals should be discouraged.

Every school boy must eat tiffin—and where parents cannot afford it, public funds must supply it. The tiffin must be plain, wholesome, generous, nutritious, digestible and varied and consist of more fruit and less meat. Sweet things must also be provided, but not until the appetite has been satisfied. On no account must bazar sweets be permitted.

Caries of the teeth and foetid breath, are rather common among school boys, due to faulty mastication and want of oral toilette. The teeth should be inspected every year and oral toilette must be insisted on. Children and their parents must be taxed for uncleanly habits.

Growth: If at any age, growth of the body occurs *at an exceptional rate*, mind and muscles fail to keep pace with it. This happens at or about puberty and whenever it happens, it demands attention. *Insufficient* growth demands better food aud more clothes. "Children of the better classes are heavier and taller in both sexes than those of the poorer classes. Boys are heavior than girls upto 12, but soon after 12, they lose their superiority for three years, regaining it by 16. In boys, the greater increase occurs from about 14 to 16 and in girls from about 12 to 15. Boys are taller than girls up to 12, when girls pass them and retain an advantage to nearly 15. In boys, the greatest annual increases are from 5 to 6 (almost 3 inches) and from 14 to 15 (about 3 inches). In girls, the greatest annual increase is about 12. In girls the increase is more uniform than in boys up to 14. In girls growth begins to slow down between 12 and 13 and at 14½ girls have nearly completed their growth while boys grow rapidly up to 19 Girls of 13 and 14 are generally taller and heavier than boys of the same age."

AVERAGE HEIGHT AND WEIGHT (English)

	Boys			**Girls**	
Age	*Weight* (℔)	*Height* (inches)	*Age*	*Weight* (℔)	*Height* (inches)
5	39·9	41·03	5	39·2	40·55
6	44·4	44·00	6	41·7	42·88
7	49·7	45·97	7	47·5	44·45
8	54·2	47·05	8	52·1	46·60
9	60·4	49·70	9	55·5	48·73
10	67·5	51·84	10	62·0	51·05
11	72·0	53·50	11	68·1	53·10
12	76·7	54·99	12	76·5	55·66
13	82·6	56·91	13	87·2	57·77
14	92·0	59·33	14	96·7	59·80
15	102·7	62·24	15	106·3	60·93
16	119·0	64·31	16	113·1	61·75

The following is the result of my examination of students in Calcutta the various columns being :—

(1) Age in years. (2) Total number of students examined. (3) Maximum height. (4) Minimum ditto. (5) Average ditto. (6) Maximum weight for the age. (7) Minimum ditto. (8) Average ditto. (9) Maximum chest girth. (10) Minimum ditto. (11) Average ditto. (12) Maximum chest expansion. (13) Minimum ditto. (14) Average ditto. (15) Maximum ditto. (17) Average ditto.

		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
														Maxim. Cranial Measure	Minimum ditto	Average ditto
7	5	4—5	3—10	4—¾	54	40	44·4	24	21¼	22 1/20	1	½	4/5			
8	15	4—7½	3—10	4—2	72	40	48·1	27½	21¼	21½	1	½	11/15			
9	36	4—10	3—11	4—3⅛	90	42	52·7	28½	21¾	23⅓	2	½	1 1/48			
10	37	4—11	4—1	4—5½	98	45	57·9	31	21¼	24⅕	2½	½	1 5/48			
11	52	5—7	4—3	4—7⅙	106	47	62	31¼	22½	24¾	2	½	1⅗			
12	72	5—11	4—5	4—8¾	105	51	69·8	32½	22½	26⅓	2	½	1⅙			
13	85	5—8	4—3	5—1/48	146	51	80·8	35	22	26 1/18	3	½	1 7/11			
14	84	5—11½	4—3	5—2¼	167	52	89·4	37¼	23	28¾	3	½	1 3/7			
15	102	5—9½	3—0	5—3¾	167	64	103·6	36½	24	29½	3	½	1 5/9			
16	88	5—10½	5—1½	5—5½	160	73	109·1	38	24	30⅕	4	½	1 5/7			
17	46	5—10	5 2	5—5⅗	242	91	114·5	46	27	31⅖	3½	½	1 11/12			
18	23	5—10	5—2½	5—5⅔	231	95	126·9	46	29	32¾	3	1	2			
19	10	6—2	5—3½	5—5⅝	215	107	118·1	41¾	30	31¾	3	1	2⅛			
20	3	5—6¾	5—4½	5—5¾	122	86	108	32½	28¾	30⅚	2	1¼	1½	22	21½	21⅙
21	3	5—7	5—2¾	5—5⅓	120	96	106·6	32	30	31 1/14	2½	¾	1 3/7	21½	20	20 27/28
22	6	5—10	5—2	5—6⅙	129	96	108·5	32¾	30	31 5/24	2¼	½	1⅛	21¾	20	21⅛
23	6	5—8½	5—1½	5—4⅓	121	96	107·5	32½	29½	30⅝	2½	¾	1⅓	21½	20	20 37/48
24	4	5—10½	5—3½	5—7⅝	124	95	114	33	30	31 7/16	2	1¼	1⅝	22	21½	13 13/17*
25	7	5—9	4—11½	5—4	136	86	106·8	33½	29½	30 5/28	2½	¾	1 5/14	21½	20½	21 1/7
26	1	...	...	5—7	...	...	142	...	...	34½	...	...	1½			22¼
27	6	5—8	5—1	5—5 7/12	108	97	103·3	32	29	30 5/12	2½	½	1 11/24	22	20¾	21 5/16
28	3	5—7	5—6	5—6½	141	106	129	35½	30¼	33 7/12	2	1	1 5/12	22	20¾	21⅓
29	1	...	...	5—3½	...	...	84	...	...	29½	...	...	1½	...	...	21½
30	2	5—7½	5—7¼	5—7⅜	140	114	127	34	31	32½	2	2	2	22	21⅛	21 9/16
31	1	...	...	5—7	...	...	129	...	...	34½	...	...	1½	...	...	20½
32	1	...	...	5—4½	...	...	91	...	...	28	...	...	2	...	...	20¾
33	2	5—7	5—3½	5—5¼	101	90	95·5	31¾	30½	31⅛	1¼	½	7/8	21	20⅜	20⅞
34	2	5—2½	5—1½	5—2	140	84	112	37	28¼	32⅝	1¾	½	1⅛	23	21½	22¼

SPREAD OF INFECTION.

Measures against Spread :—(1) As soon as ever a child at school is detected to be suffering from an infectious disease, the class must be promptly closed, till the maximum incubation period of the disease is passed. If a child comes from an infected house, he should be sent back and kept at home, till the infection in his house is over. (2) Notification of infectious diseases must be compulsory and the school medical officer should have power to close a school for such purposes. (3) Medical inspections should be frequent during epidemics ; and, scholars, who look suspicious, should be excluded. There should be inter-notification between the Headmaster, school medical officer and Municipal Health Officer regarding every pupil or class dealt with. (4) Cleansing and disinfection of schools must be done thoroughly, if necessary.

The causes of spread are : Presence in class room of—mild and undiagnosed cases, "carrier" cases, cases incubating the disease in them, and sick children and contacts returning too early to school. The free contact of boys at play, the common cloak room, books &c. also help the spread.

Period of Exclusion recommended in infectious cases :—

Diseases	*Period of Exclusion of those suffering.*	*Exclusion of children from infected houses.*
1. Small Pox	...Until complete cure, every scab falling off scalp and body, in case of small pox.	...One week after the house is free from infection.
2. Cholera		
3. Diphtheria.	...Until a fortnight after discharge or until disappearance of germs.	
4. Membranous croup		
5. Scarlatina	... Until 15 days after discharge.	
6. Erysepelas	... After recovery ...	Not necessary.
7. Enteric		

Diseases	*Period of Exclusion of those suffering.*	*Exclusion of children from infected houses.*
8. Measles ...	At least one month	(*a*) *Infants*—15 days from occurrence of last case. (*b*) *Seniors* – not to be excluded if they had the disease; or 15 days from occurrence of first case.
9. Mumps ...	One month ...	(*a*) *Infants*—3 weeks. (*b*) *Seniors* – as in case of Measles.
10. Whooping cough ...	At least 5 weeks from commencement of whoop and as long as cough continues.	(*a*) *Infants* : 2 weeks. (*b*) *Seniors* : As in measles.
11. Chicken pox ...	2 weeks or until every scab is off body or scalp.	As in measles.
12. Ringworm. 13. Favus. 14. Scabies. 15. Ophthalmia. 16. Trachoma	Till cure ...	Not to be excluded.
17. Consumption ...	Exclude wholly if the disease is accompanied by coughing	Ditto.

The School doctor.—He should be a qualified practitioner of at least five years' standing, versed in school hygiene as well as in general hygiene and should take a lively interest in his work. It is best to have one and only one medical officer, who should be in constant touch with the teacher, pupils and the Health Officer of the local board. He should have a separate furnished office, one or more nurses, a clerk and a disinfecting staff. Junior medical officers may undergo training under his eyes. He should visit the Boarding every day, punctuality being a great consideration with him, and visit the school and go round every part of it occasionally, noticing specially, ventilation, lighting, cleanliness as well as signs of overpressure, fatigue &c. He should note the quantity and quality of mental as well as physical work and study the effects thereof. During infection and epidemics, he should visit as often as necessary. He should inspect every scholar on admission, thereafter every third year ; and he should examine twice a year those who have defective vision, examine the relative heights of desks, seats and scholars ; and once a year the height and weight of all pupils. He should supervise the work of nurses, instruct the school authorities upon the care of delicate and defective children, lecture to teachers on school hygiene and elementary physiology, deal with absent students who have not sent medical certificates, examine medical certificates granted by others, investigate all epidemics and outbreaks of infectious diseases, advise the school authorities upon all sanitary defects, and regulate the dietary of school boys (specially, supervising water and milk supply). There should be a central medical organization to which the school medical officer should belong ; this central organization is to cooperate with, but be independent of, the local Health Officer. **The Public**—Public cooperation by means of funds and voluntary workers is essential to the success of the whole scheme. There should be voluntary committees charged with work, such as *Care committees* to look after the free dieting of the indigent scholar at midday and after all that pertains to him at home and at school ; *Out-of-School-children committees* to visit and keep watch upon those children whose temporary ailments keep them out of school ; *After-care* and *following-up committees* to look after school leavers ; *Tuberculosis-care committees* to look after tubercular children ; *Lecturing committees* to organise regular popular lectures on hygiene. There should be free and separate *clinics* for the examination and treatment of diseases of ears, eyes, nose and throat, teeth, skin. There should be *open-air schools* and *play ground classes* ; public *swimming baths* and *gymnasiums*, specially reserved for children. There should be *parks* set apart for children ; there should be institutions for *remedial exercises* under skilled experts.

The **teaching staff** must be living models of cleanliness and should freely participate in the scholars' games, exercises and amusements. They too should be medically examined as are their scholars and sanitary practices and school buildings must be models in their own line. In India, work on these lines should commence at once, even though it be on very humble scale.

Special Schools—should be set up for the blind, myope, deaf and dumb and the hard-of-hearing pupils and for stammerers &c.

CHAPTER XXIII.

METEOROLOGICAL INSTRUMENTS.

Their objects are to find out the following.—

(1) Atmospheric pressure—by the use of Barometer.
(2) Altitudes—use Aneroid Barometer.
(3) Velocity of Wind—use Anemometer.
(4) Humidity—use Hygrometer.
(5) Rate of Evaporation—use Atmometer.
(6) Amount of Rainfall—use Rain Gauge.
(7) Amount of Heat—use Thermometer.

Barometer (ordinary).

THEORY : (*a*) The weight of the atmosphere at the sea-level supports a perpendicular column of—Mercury of 29·992 inches (=760 millimetres), of Glycerin, 324 inches, and of Water, 34 ft. [Hence, water barometer is most sensitive, but inconveniently tall.] (*b*) Mercury—falls about $\frac{1}{1000}$th inch for every foot of ascent above sea level.

CONSTRUCTION : (1) Take a vertical tube 33″ long, closed and vacuum at one end,—the other (open *end*) ending either in (*a*) a bent short arm of 9″ or (*b*) into a cistern of mercury, as in Fortin's instrument. (2) Carefully and truly fix it by a plumb-line, in good light and protected from sunshine, rain and winds. (3) Attach to it a fixed scale, divided into tenths of inches, and have a sliding scale or vernier (divided into 1/100th inch). Adjust the level of the mercury to the zero of the scale, before any reading is taken.

READING.—Read off with help of the vernier ; multiply the number of divisions on the vernier so obtained, by 0·002 and add the result to the already observed height on the barometer scale ; for temperatures above 32°F, make corrections by Glaisher's tables. Always take simultaneous thermometric readings. Barometric observations are always expressed to the third place of decimals. *Isobarometric lines*—are indicators of areas on maps over which identical pressure prevails. BAROGRAPH—is an instrument for automatically recording barometric readings for 24 hours.

ANEROID BAROMETER. PRINCIPLE : The weight of 1 cub ft. of dry air at 32° F and 30″ Hg$=$566·85 gr. Air expands $\frac{1}{491}$ of its volume for every 1°F rise ; and the weight is inversely as volume. CONSTRUCTION :—A watch-shaped metal box is exhausted of air and to its two flat surfaces a sensitive spring is fixed. Variations in atmospheric pressure working on this spring, causes the spring to move an indicator on the dial. TO READ : Take readings (to the nearest 1/100 inch) at commencement and termination of an ascent; subtract the one from the other, and multiply the difference by 9 : this gives the height of the ascent in feet. In the RECORDING ANEROID BAROMETER, a series of vacuum chambers is made to work on a sensitive index which records the results.

Thermometer.—PRINCIPLES.—The expansion and contraction of mercury and alcohol exposed to varying degrees of heat and cold are measures of the temperature. Mercury has a very high boiling point (675° F) and alcohol has not yet been frozen. The thermometers are graduated between freezing and boiling points, which are according to the centigrade scale O° and 100°C respectively and to Fahrenheit, 32° and 212° F respectively and to Reaumur,—O° and 80°R respectively.

VARIETIES : Thermometers are :—

A. *Shade Thermometers.*

I. Ordinary—on centigrade, Reaumur or Fahrenheit scale.

II. Registering—(*a*) Minimum—Rutherford's and Casella's. (*b*) Maximum—Negritti's, and Phillip's. (*c*) Combined Maximum and Minimum—Six's thermometer.

III. Recording—Cripp's or Richard's.

B. *Sun Thermometer.*

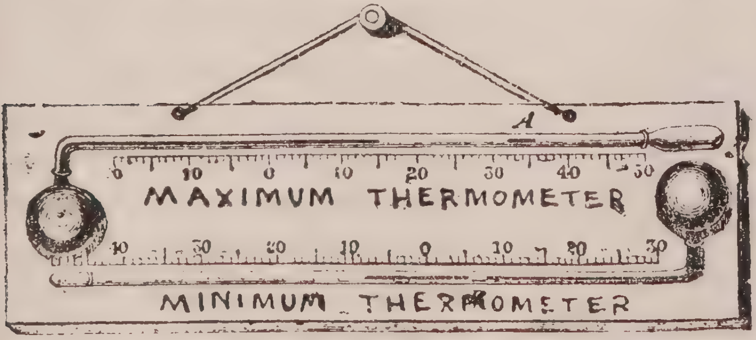
I. To measure solar radiation or rather the total heat received from the Sun : (1) Blackened-bulb Maximum thermometers (*b*) Blackened and non-blackened bulb thermometers—both exposed in vacuo together.

II. To measure terrestrial radiation,—the minimum thermometer.

III. To record (*a*) Sun-shine—Campbell Stoke's or Whipple-Casella's instrument ; (*b*) Sun-light—Jordon's instrument.

[Shade Thermometers—are to be kept in the shade, protected from all direct rays of the sun and reflected or radiated heat. Sun thermometers are exposed directly to the sun. Shade Maximum and Minimum thermometers should be placed horizontally in the shade or in a Stevenson's louvred box, 4ft above the ground and at least 20ft. away from building or other sources of radiation.]

(*a*) Maximum Thermometer :—Made of mercury, it is self-registering, by means of an air bubble or a break in the column of mercury. It records the highest temperature reached during a period of exposure of the instrument.



(*b*) Minimum Thermometer :—Made of alcohol ; it is self-registering, by means of an index. It records the lowest temperature reached during a period of exposure of the instrument.

(*c*) EARTH THERMOMETER—is a maximum thermometer suspended inside a stout iron tube, 5ft. long ; it is *used* to measure temperatures of earth down to 5 ft. depth.

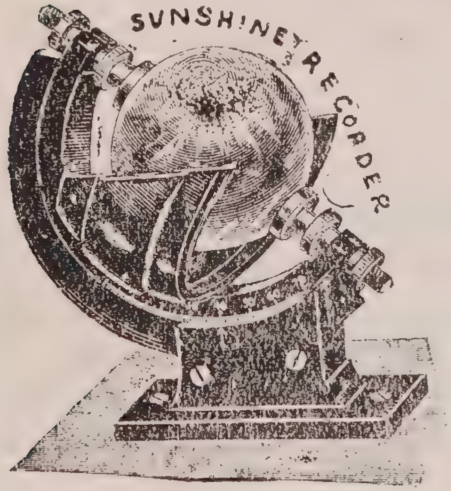
(*d*) SIX'S THERMOMETER—made of alcohol and mercury ; it is self-registering by means of a steel index. One arm of it records the maximum, the other, the minimum temperatures.

(*e*) THERMOGRAPH—is an instrument *meant for* recording 24 hours' temperature on the map of a place. *Isochimenal lines* indicate regions having the same winter temperature and *isothermal lines*, the same annual temperatures.

(*f*) VACUUM SOLAR RADIATION THERMOMETER.—It is a *maximum* mercurial self-registering instrument, with a blackened bulb, placed inside a glass case, from which air has been exhausted. It is placed 4 ft above the ground, exposed to the direct rays of the Sun. Amount of solar radiation is found out by subtracting the maximum temperature in the shade from that in the Sun.

(*g*) TERRESTRIAL RADIATION THERMOMETER—is a *minimum* shade thermometer, placed close to the ground, the bulb resting on grass. The amount of terrestrial radiation is found by subtracting the minimum air temperature in the shade from that on the grass.

(*h*) CAMPBELL-STOKES' OR WHIPPLE-CASELLA'S SUNSHINE RECORDER—is a strip of millboard on to which the Sun's rays are concentrated through a large spherical lens. When the Sun shines, a charred line is burnt on the millboard and when it does not, the charring ceases. *Results* are expressed in percentage of the possible amount of sunshine.

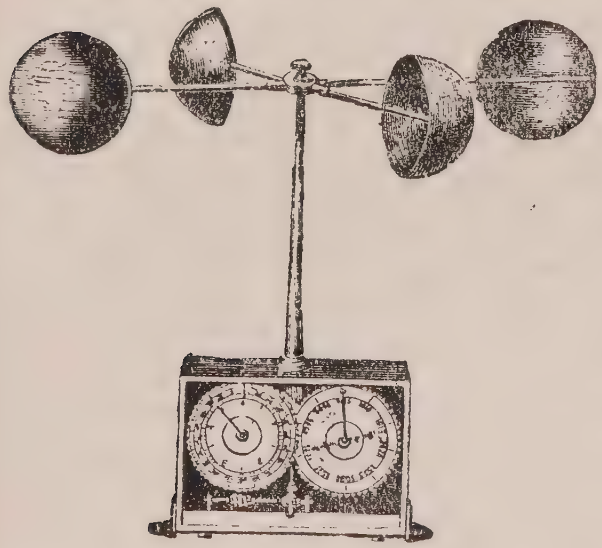


(*h*) JORDON'S SUNSHINE RECORDER.—It records the duration and intensity of sun-light (rather than sunshine) through a small aperture on a sensitive cyanotype paper. The instrument has to be adjusted to the Sun's inclination and to the latitude of the place.

To find out the mean temperature of the day—(*a*) take a single reading at 9 p. m ; (*b*) take the mean of two readings at 9 a. m. and 9 p.m. or (*c*) take the mean of maximum and minimum recorded temperature. To convert from one scale into another, remember :

$$F=\tfrac{9}{5}C+32.\quad F=\tfrac{9}{4}R+32.\quad C=(F-32)\tfrac{5}{9} \text{ and } R=(F-32)\tfrac{4}{9}.$$

Anemometer—By means of four revolving cups, wind is caught and the velocity of the caught wind is measured thereby—the cups moving at a rate equal to only $\frac{1}{3}$ that of the wind. Remember that (*a*) $(\text{Velocity of wind in miles per hour})^2 \times 0{\cdot}005 =$ wind pressure in ℔ per sq. ft. ; and (*b*) Velocity $= \sqrt{200 \times \text{wind pressure}}$ (*c*) Average velocity of wind = 6 to 8 miles per hour. (*d*) On the Beaufort Scale, *light* wind travels 13 miles per hour ; *moderate* breeze, 23 ; *strong* breeze, 34 ; and *gale* 65 miles per hour.



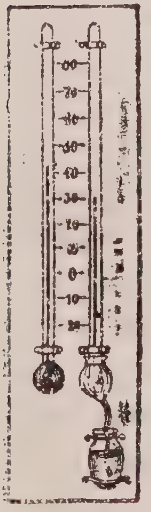
Hygrometer : OBJECT is to find out *dew point* (=the temperature at which air saturated with moisture deposits its water) ; this dew point tells us of the degree of humidity— i. e., of the percentage of saturation or weight of water existing in the air) at that given temperature. PRINCIPLE : Air inside a close space is cooled artificially and dew or moisture from atmosphere is thereby caused to be deposited on the cooled closed space ; the temperature at which this takes place (the dew point) is read off simultaneously. Note that the higher the temperature, the larger is the amount of vapour which a cub. ft. of dry air can take up before being saturated. There are two varieties of this instrument—for direct and indirect determination of dew point.

DANIELL'S HYGROMETER : It is a sort of vacuum inverted U-tube with one arm longer, and both arms ending in bulb. The longer arm contains ether and a thermometer, the shorter, ether vapour. When the bulb of the longer arm is cooled by ether-soaked muslin, the shorter becomes cooled : hence moisture from atmosphere is deposited on it. Directly this occurs, read off the temperature at which dew *disappears*. The mean between these two is the dew point.

REGNAULT'S HYGROMETER.—Two cylinders (slightly open at one end and each having a thermometer) are taken, one being half filled with ether, the other being empty. By means of a hollow upright, an aspirator communicates with both cylinders. When air is aspirated through both, that containing ether becomes cooled and moisture from atmosphere is deposited on its surface ; the temperature is at once read off. The other thermometer in the empty cylinder records only atmospheric temperature.

DINE'S HYGROMETER.—"A vessel which holds ice-water has a bright metal plate with an attached thermometer in its roof. As the cold water is made to flow under the plate, the outside air in contact with it becomes chilled ; and when the dewpoint, as shewn by the deposition of dew, is reached, it can be read off from the attached thermometer."

WET AND DRY BULB HYGROMETER.—Two identical thermometers are placed in the shade protected from air currents and direct sunshine. The bulb of one thermometer is kept wrapped by wet muslin. The evaporation of moisture from the wet bulb (which occurs only so long as the surrounding air is not saturated) causes loss of heat ; it therefore reads lower than the dry bulb. *This hygrometer tells us of*—(*a*) Relative humidity—*i.e.*, the amount of moisture present in air, expressed as a percentage of the amount just necessary to cause saturation. This is found from tables :—(Elastic force or weight of 1 cub. ft. of aqueous vapour at temperature of dew point ÷ elastic force of aqueous vapour at temperature



of air) × 100. The greater the difference between dry and wet bulbs, the lower is the relative humidity. If dry and wet bulbs record the same temperature, the air is saturated with moisture. (*b*) Dew point—*i.e.*, the temperature at which the amount of moisture actually present in the air causes saturation. Dew point $= Td - F\,(Ta - Tw)$ ($Td =$ dry-bulb temperature, $Tw =$ wet-bulb temperature, F = the factor opposite the dry bulb temperature on Glaisher's table. (*c*) Weight of vapour in a cubic foot of air—from which can be deduced the additional weight of vapour necessary to cause saturation. Or,—(*d*) The drying power of air. ['*Elastic force of vapour*' or the '*Tension of aqueous vapour*' is the amount of barometric pressure which is due to the aqueous vapour in the atmosphere. If the temperature of the air is lowered (∴ also the tension of aqueous vapous), a temperature is soon reached at which the air is saturated with moisture; and then the slightest further reduction in temperature will cause a deposition of dew (dew point). The tension of aqueous vapour is ascertained from tables or by formulæ."]

A saturated atmosphere at say—35°—50°F—is intolerably chilly; 50°—65°F—is not uncomfortable; 65°—80°F—is oppressive and sultry; 85°—O is most oppressive; and 90° F to 100°F is perhaps fatal.

DE SAUSSURE'S HAIR HYGROMETER.—This is a somewhat unreliable instrument, being made of a piece of stretched hair carried round a pulley, to which latter is attached an indicator; the hair contracts with lesser and expands with greater degree of humidity.

Atmometer—measures the amount and rate of evaporation. A known volume and weight of water is allowed to evaporate in a given vessel, so that the surface area is known and the loss in volume or weight of the water determines the amount and rate of evaporation.

Rain gauge.—(1) ORDINARY.—This is a vessel with a circular copper funnel at top, sunk in ground level, away from shrubs and buildings—so that, the collecting surface is 1 foot from the ground. By means of a measure glass, graduated according to the area of the top of the funnel, is indicated the fall of rain as decimals of an inch ; *for example* : Suppose the area of the top of the circular funnel is 50 sq. inch. Mark off the level at which 50 cub. in. water stands in the measure glass. The portion below this mark may be graduated into 100 equal parts. Then as each sq. in. surface collects 1 cub. in. water, the rainfall is 1." [*In times of snow*—(*a*) add to it a measured quantity of warm water and record the extra water derived from the snow, as rain water ; (*b*) measure also the average depth of adjacent snow]. See figure page 69.

(2) CROSLEY'S SELF-REGISTERING.—Every $\frac{1}{100}$th inch of rainfall is recorded on a dial by each compartment of the collecting bucket tipping off when full.

CHAPTER XXIV.

CLIMATE.

THEORETICAL CONSIDERATIONS.

Definition.—"Climate" is the sum of the effects of the Sun, the atmosphere and the earth in any region or country. (1) The *Sun* influences climate by its heat, light and chemical rays ; (2) the *atmosphere* by its chemical composition, its temperature and diathermancy, its humidity, pressure, motion (winds) and electrical conditions ; and (3) *the earth* by its position (latitude), relative proportion of land and water, ocean currents, soil, vegetation, altitude and configuration of surface. 'Climate' relates chiefly to the air, temperature, moisture, sunshine, winds etc., specially in so far as they concern the health or comfort of mankind.

'*Climate*' refers to average conditions of a place for a whole year, while **'weather'** refers to those atmospheric conditions prevailing at a given time.

Wherever placed on the globe, a man *in health* can adapt himself to the climate of the place—maintaining normal temperature and bodily functions. It is those that are *constitutionally* weak or suffering from actual *diseases* that require searching consideration of the climate of a place before being transported thereto.

[The word 'climate' is derived from Greek *klima*=a slope, the idea being that the diversities in the qualities and conditions of the atmosphere were the effect of the slope or the distance from the equator on the earth. This is partly true and, on this principle, climate has been **divided into** : (*a*) *Hot region*—between the equator and the isothermic line of 77°F. (*b*) *Warm region*—between isothermic lines 77° and 59°F. (*c*) *Temperate regions* between isothermic lines 59° and 41°F. (*d*) *Cold region*—between isothermic lines 41° and 23° F ; and (*e*) *Polar region*—between isothermic lines 23° and 5°F.]

Causes of Climate.—Climate depends on :—(A). **Atmosphere** :—*i. e.*, on its chemical *composition*, floating *impurities*, *temperature* and diathermancy, degree of *humidity*, *pressure* or density, light and *transparency*, *electrical* conditions and its *circulation* (prevailing winds)—all connected with and constantly modified by one another ; (B) Nature of **Surface of Earth**—especially as regards—cultivation, proximity to marshes, or oceans, drainage, forests ; and (C) **Population and Manufacture.**—We shall consider each of these causative factors in brief.

I. **Chemical composition.**—Air all over the earth is **not of uniform composition** and the slightest changes in its composition are of the utmost importance, because of the huge quantities of air that we inhale daily and of the practical impossibility of rendering air free from noxious ingredients, inspite of the use of cotton and charcoal air-filter. Let us study the components individually.

Oxygen.—The difference in the proportion of oxygen in air of different localities rarely exceeds $\frac{1}{10}$th—a by no means negligible amount, considering how much of noxious substances we simultaneously inhale! At the same spot, the amount of oxygen varies, being higher in wet *weather* (rains) than in dry foggy weather, in *open* yards and maidans than within houses and rooms.

Carbon Dioxide.—In the amount found in air, it is probably not immediately poisonous, though the amount of it is a measure of the other deleterious substances that accumulate simultaneously, and are really the cause of mischief. The gas tends to increase wherever there is overcrowding (as in schools).

Ozone (normally, 1 in 10,000).—It is found to decrease in amount as we proceed—from sea, to top of mountains, green fields and woods, barren open country, villages, large towns, crowded sick rooms, to neighbourhood of decaying organic substances. We know but little of *its effects* on the human system; but possibly, it helps to purify the atmosphere and has a *soporific* effect on some persons, who sleep better and quicker in the air of mountain and sea shores.

II. **Floating impurities of air.**—They are *organic* (*e. g.*, pollen grains, algæ, sporidiæ, bacteria, insects, animal tissue &c.) and *inorganic* (salt, silicious matter, chalk &c.). They are *wholly absent* in sparsely inhabited high elevations and *abundant in* thickly populated lower regions. The *influence* of these on wounds and inflammatory processes, on many species of fever and on some constitutional diseases as well as the usefulness of some of them as agents of light, of purification and metamorphosis of matter should be remembered.

III. **Temperature.**—[Broadly speaking, *latitude* and *altitude* determine the temperature of a place—the nearer it is to the equator, the warmer a place is and for every 100 yards of altitude, cold increases 1°F].* For determination of the value of climate of a place, temperature (heat) is of the utmost importance, and we describe it in detail:

Sources of heat to the earth are four, *viz.*,—(1) The *Sun*—its direct heat and radiant heat, (2) *radiant heat* from the moon, stars, interior of the earth, (3) *terrestrial radiation*, and (4) currents of *warm wind.*

Direct and Radiant heats:—(1) DIRECT, RADIANT OR SOLAR HEAT—is the heat radiated directly from the Sun; it has the property of greatly warming objects on which it falls (*e.g.*, human body, soil &c.), but has very slight power of warming the media (atmosphere &c.) through which it passes. This property of gaseous bodies like air of allowing direct heat rays to pass through them without raising their temperature is called *diathermancy* or *transcalency* of gases. The direct heat absorbed, is thus *disposed of*:—(i) Substances that are *white*, reflect and scatter about them the solar heat—thus increasing the warmth of the solar radiation but helping to keep the atmosphere cool; hence, snow fields, light coloured soils, chalk cliffs, white-washed high walls, sheets of inland water, sea surfaces—all keep the air cool, but increase the Sun-warmth. (ii) *Black* substances absorb heat; as the absorbing power of substances is inverse to their reflective powers, black substances decrease the warmth of solar radiation but increase the atmospheric temperature. Hence, "the nearer the colour of the ground approaches to white, the greater will be the Sun-warmth and the cooler the air; whilst, the darker the ground, the warmer will be the air and the less will be the heat of the solar radiation felt." (2) SHADE, AIR OR REFLECTED HEAT—is the warmth communicated to the air by the surface of the earth, of the heat it had absorbed from the Sun's rays. Though 25% of the heat of the Sun's rays, which fall on the outer limit of our atmosphere are absorbed, yet these rays do not warm the atmosphere to any appreciable extent. Note that the lower the altitude of the Sun, the greater is the increase of warmth by reflection from water; hence, in winter, the great advantage in, say, the British isles, in removing the cold of mornings and evenings. [Sometimes, part of the shade heat is due to currents of wind or air from *distant* parts].

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* At meteorological stations the following temperatures are usually recorded: (1) Shade temperature—by maximum and minimum thermometers; (2) Solar radiation—taken by black bulb and bright bulb thermometers in vacuo, mounted on posts 4 ft. above the ground; (3) Terrestrial radiation—by a sensitive spirit minimum thermometer; and (4) Earth temperatures—by Symon's earth thermometers.

DIATHERMANCY—or the property of allowing heat rays to pass through unabsorbed—is not absolute so far as our atmosphere is concerned, for it contains water-vapour. Hence, because of the presence of aqueous vapour in our atmosphere, and proportionate to the quantity of vapour present, our atmosphere—(α) *retains* part of the direct heat; (β) *sends down* part of the heat to earth to be absorbed; and (γ) *reflects* some of the heat back into the air; and thereby—helps to keep the night air comfortably warm.

Distribution of Temperature in the Atmosphere.—Owing to differences in density, consistency and smoothness in the earth's surface, the temperature of places equidistant from equator is not uniform. If, on a map, lines are drawn connecting places which have the same mean annual temperature **(iso-thermal lines)** we find that—(*i*) on the *northern* hemisphere, there is a great difference between the course of the winter, the summer and in the annual isothermals; and (ii) in the *southern* hemispheres, the isothermal lines are less deviating than in the northern and with greater distances from the equator they become nearly parallel. [Lines showing—(*a*) places with the same mean annual temperature=*iso-thermal*; (*b*) places with same temperature in winter=*iso-chimenal lines*; and (*c*) places with same temperature in summer=*iso-theral lines.*]

Disturbing Factors of Solar climate :—We have seen that it is the sun that is the greatest contributory factor to the causation of climate. But certain other factors modify the influence of the sun. These disturbing factors are practically four in number, viz, the continents, sea, sea currents and winds. On a broad basis, the following are the factors which have—

WARMING INFLUENCES.

1. Warm *oceanic currents.*
2. A *divided* or intersected configuration of the land, with projecting peninsulas and deep re-entering bays.
3. *In colder regions*, position of the land near sea, free from ice.
4. *In warmer regions*, proximity of a mass of continent extending into torrid zone.
4. Prevalence of *warm winds* (S & W in winter).
5. *High* mountain *chains*, preventing access of winds from cold region.
6. Serenity of *sky* during summer months.

COOLING INFLUENCES.

1. *Elevation* above sea level.
2. A *massive* continent having a coast line little varied by indentations.
3. Uninterrupted extension of land *into direction of poles.*
4. A geographical position, in which the tropical portions are occupied by *sea.*
5. *High* mountain *chains* preventing access of wind of warmer regions.
6. Extensive *forests* (*i. e.*, shade, evaporation, radiation).
7. Prevalence of cold *winds.*
8. A cloudy *sky* and misty air in summer and a serene sky in winter.

Disturbing effects of Continents on Temperature : Speaking generally, extensive tracts of land behave the reverse of seas :

(*a*) *in summer*, they become very heated, thus causing cold wind from other parts to flow in ; (*b*) *in winter*, in the higher latitudes, they become excessively cooled—and cold wind from them flows towards regions of lower pressure. But, over special areas, special conditions prevail. Thus,—

I. EXTENSIVE ARID PLAINS.—The day-heat and the night-cold are very striking here—the more so, if it is a desert.

II. DESERTS—are characterized by—clear sky, abundant sunshine, dry, aseptic air, extremely variable temperature and frequent dust-storms. Hence, sores heal rapidly and even consumptives with cavities have a hope here, provided, they select places where variations of temperature are not so sharp and dust-storms are at a minimum, as at Cairo, Assouan, Luxor or Haluen in Egypt ; or Sind, Rajputana and S. Punjab in winter in India.

III. HILLY DISTRICTS.*—The climates are less extreme here than over plains. Owing to unequal heating, on hills local currents of air with changes in temperature and moisture are produced ; but, generally, the air is dry and hot.

IV. MOUNTAIN CHAINS.—Climates over such places are governed by several factors viz., their abruptness, elevation, extension, direction and degree of vegetation. They bar the passage alike of cold and warm winds and cause moisture-laden warm winds to give rain : hence, regions to the leeward of the chain, have higher or lower annual temperatures and drier climate. RAVINES AND VALLEYS—afford protection from strong and cold winds but are usually water-logged and therefore malarious—as the Tarai regions.

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* *Clayey* and *alluvial* soils (containing much decomposed organic matter) are damp and malarious. *Gravel* is healthy, *lime* is dry and healthy ; *chalk*, when it overlies clay, is damp and malarious.

V. DRAINED[*] AREAS (as contrasted with undrained areas): The temperature here generally is more equable; in summer, it is greater by 1°5 to 3°.F; in cold weather and during sudden falls of temperature, the cold passes quickly. Hence, drained areas are beneficial to phthisical patients.

VI. VEGETATION[†] AREAS.—Speaking generally, the ground temperature is comparatively cool and equable. As the quantity of vegetation varies, we may have three conditions:—(*a*) *Forests of large trees*—(*e. g.*, pine forests) cause equable climate, cooler days, warmer nights and purer air; they keep off chill wind, render the place humid—with mist or rain. (*b*) *Grass land*—tends to diminish the summer temperature and the air more humid. (*c*) *Peat & Marsh lands*—render the soil damp, the atmosphere humid and cool, and give rise to mist, malaria and miasma.

Disturbing influence of Sea on climate.—(*a*) The air immediately in contact with sea-surface is *surcharged with water vapour* and, as such, prevents radiation from sea-surface considerably. Hence, the temperature upon and around the sea is HUMID. (*b*) Water of the sea being saltish, the surface of the sea cannot freeze, unless the temperature has fallen through the whole of its depth to 28.°4 F; while, in fresh-water inland-lakes, the surface water may freeze, the lower depths retaining a temperature of 39°2F. Lakes, thus, diminish the summer heat; but when frozen over, lakes cease to influence the climate; while the sea continues to *modify the heat* in summer and the cold in winter;—or, in other words, marine climate is more or less EQUABLE in temperature. (*c*) The sea furnishes a very wide expanse of open space; thus sea air is practically *sterile and charged with ozone.*

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[*] *Irrigated* lands near canals and rice fields are liable to become malarious.

[†] *Rank vegetation in ill-drained soils* renders the climate damp and malarious.

(*d*) The sea has two sets of temperature: the surface-temperature, which is variable at different parts of the globe; and deep-sea-temperature—which is practically 32° to 35°F everywhere on the globe. (*e*) The water of the sea allows the solar rays to penetrate to great depths, and owing to excess of humidity in the air on its surface, surface radiation is not free; thus, in 24 hours, the daily variation in the temperature of the sea is not more than $5\frac{1}{2}$° F., while that on land surface may be even 80° to 90° F.

Disturbing influence of Sea Currents on climate.—Owing to its fluidity and to differences in temperature of the restless sea, there is a constant communication between different parts of the seas by means of currents. These currents are either general or local.

(*a*) GENERAL OCEANIC CURRENTS—consist of—(*i*) An *underflow* of *cold*, *polar* water from the polar regions *towards* the equator: though this is a deep current, in different localities, it comes to the surface, forming bands of cold water and cold currents along shores. [Not all parts of the sea have the same glacial and equatorial currents as the great open Atlantic and Pacific.] (*ii*) An *upper* flow of *warm equatorial* water from the equator *towards* the poles, where, becoming cold, they sink to the bottom and return as polar current.

(*b*) LOCAL OCEANIC CURRENTS—produced by unequal distribution of land and formation of coast lines. Probably, the prevalent winds have a great hand too in this matter. Some instances of local currents are: (i) *Gulf stream* or *Florida current*—a warm current starting from the Florida Channel to Cape Hatteras, to south of Nova Scotia, to the British Isles, to Iceland and Norwegian coasts, down to the west coast of

France. Some bands of this stream (called *Rennei's current*) warmer than the rest, flow eastwards into the southern part of the Bay of Biscay, thence to the Scilly islands, thence to the south west coast of Ireland. (ii) Warm current along the east coast of South America, from the equator southwards. (iii) Current along part of east coast of Africa. (iv) The *Kuro-Siwo*—in the North Pacific, which runs up into Behrings Strait. (v) *Humbolt's current*—on west coast of South America.

Disturbing influence of Warm Winds on Climate.—Winds from temperate regions bear with themselves the heat of the region over which they have passed; thus, when the wind is—(*a*) *Dry*—as, after blowing over deserts, it raises the temperature of the country to which it arrives; (*b*) *Moist*—wind may itself be scarcely warmer than the air of the country which it reaches, but its aqueous vapour, during condensation as snow, or rain, gives up a large amount of latent heat; and (*c*) *Coming from overseas*—may be warm from blowing over the warm sea currents.

IV. **Humidity.**—It is the amount of aqueous vapour in the atmosphere. It VARIES WITH temperature, being doubled for every rise of 27° F temperature. Humidity of air is of the greatest IMPORTANCE in considering the effects of tropical climate, for, heat becomes intolerable in the proportion to which humidity may exist. A constantly changing and variable quantity of aqueous vapour is always present in the air—the changes being due either to evaporation or to condensation. Humidity is of two kinds: **Absolute humidity**=the weight or amount of water-vapour actually present in a definite volume of air, of a given temperature, at any given moment, regardless of saturation; we refer to absolute humidity, when we speak of 'dry', 'moist' or 'humid' air; **Relative humidity**=the proportion of the weight of water actually present in a known volume of air, to the weight of water which is required to saturate the same volume of air at the given temperature and is expressed as a percentage. [When relative humidity is low, the air is dry ; when it is high, air is damp. Air is *very dry* when it contains 55% moisture ; *moderately dry*, 55—75% ; *moderately moist* 75 to 90°/o ; *very moist*, 91—100°/o]. [Humidity is greater about sunrise ; least during the first afternoon-hours ; lower in summer than in winter ; greater in inland than in marine climates].

ABSOLUTE HUMIDITY IS AFFECTED BY four factors, *viz.*, (*a*) *Seasons* : it is higher in summer than in winter ; (*b*) *Situation* : the variation is greater in continental than in marine or insular climates ; (*c*) State of *sky* ; (*d*) Movements of *air.* [The last two are factors in the *daily* variations of absolute humidity].

RELATIVE HUMIDITY IS AFFECTED BY :—(*a*) *Seasons* : it is lower in summer than in winter ; (*b*) *Situation* : variations are greater in inland than in marine climates ; (*c*) predominant *winds.*

Relation between Temperature and Humidity.—(1) The humidity of air INCREASES in direct proportion to the rise in the temperature ; hence the increase of 'absolute' humidity in summer—the lower 'relative' humidity in summer being due to the inability of the evaporation to keep pace with the rise in the temperature. (2) Humidity is LOWERED if the temperature of air is lowered (therefore, the 'relative' humidity rising) till saturation-point of relative humidity form in it—one of these three : (i) *dew*—which is deposited on solid bodies ; (ii) *mist* or collection of water vesicles ; or (iii) *cloud*=aggregation of mist formed at higher level as minute ice-needles. (3) EQUILIBRIUM (or a sort of it) between lowering and increasing of humidity—is maintained by the power that air possesses of causing evaporation ; hence, inspite of constant rainfall, evaporation helps to maintain the moisture of the air. Evaporation depends on the temperature, relative humidity, density and degree of motion of the air.

Clouds—Clouds are aggregations of water vesicles or minute ice-needles ; they are usually *found at* moderate elevations. *They influence climate by*—their power (i) to obscure or modify the sun's rays ; (ii) to prevent radiation of heat from the earth's surface, thereby increasing heat of the atmosphere ; and (iii) to become rain and snow.

Clouds are called (1) *Cirrhus* (=feather like) which float at 6 km. or upwards. (2) *Cumulus* (heap cloud). (3) *Stratus* (layer cloud)—stripy and massive, arranged in layers (600 metres up). (4) *Nimbus* or dark rain clouds.

Rainfall. RAINFALL IS GOVERNED BY : (*a*) *Winds*—their temperature, moisture, velocity and electric conditions. (*b*) *Latitude* : generally speaking, rainfall decreases with increasing distance from equator to the poles ; but rainfall is zero over the Shahara and over-abundant at Cherapoonjee (in Assam). (*c*) *Elevation* above sea-level :—This has no constant influence, though, with increasing elevation, the amount of rainfall may increase, as in the Alps. [But not so in America]. (*d*) *Moisture* : Neighbourhood of sea, or exposure to moist winds—increases rainfall. (*e*) *High mountain chains*—which, by preventing the passage of clouds and cooling their temperature, increase the rainfall.

Number of rainy days does not correspond to the amount of rain-fall ; as a rule, the number of rainy days increases with the distance from the equator ; while, the amount of rainfall decreases. In considering climate, the number of rainy days in a place, is more important than the total rain-fall.

V. **Atmospheric Pressure.**—This is a causative factor in the production of prevailing winds and rainfall. Atmospheric pressure *varies with*—(*a*) the degree of latitude, (*b*) elevation above sea-level and (*c*) periods of the day and the year. [Owing to diminution of atmospheric pressure at high altitudes, air there is *rarefied*, *cool*, *dry* and *pure* and ascents of mountains leads to bleeding from nose and ears. At 20,000 ft. above sea level, human existence becomes impossible.] Ordinarily, at sealevel, air-column per sq. inch exerts a pressure of 14¾ lbs (=weight of a column of mercury 30.") **Compressed air** is now used as a therapeutic agent in the treatment of bronchitis, emphysema, pleurisy, pneumonia.

VI. **Light.**—Its importance on (*a*) the proper development of an animal, (*b*) the amount of CO_2 exhaled by an animal, and (*c*) the formation of chlorophyll by plants—cannot be over-rated.

VII. **Electricity of Atmosphere.**—All that we can say is that the air of some places is electro-positive ; and patients similarly charged are benefitted ; while those electro-negatively charged, become worse.

VIII. **Winds.**—Owing to changes in temperature, moisture and pressure of different parts of the globe, air is in constant circulation, thereby carrying the climate of one part of the world to another. Hence result general and local winds.

(A) **General Wind Currents.** They are permanent. (*a*) *Heat* of the tropics raises wind to higher regions, whence the wind flows *towards the poles*. (*b*) *Cool* winds from the poles rush *towards the equator* (TRADE WINDS) to take the place of the light (∵ heated) equatorial wind. But, as the earth is rotating from west to east, this inflowing wind takes an easternly direction in its lower strata and westernly direction in the higher regions. The trade wind (*i.e.*, wind flowing from the poles to the equator) undergoes further changes in its passage across the Indian Ocean and becomes monsoonic wind in India, causing general rainfall and moderating the warmth of the climate from June to September.

(B) **Local winds** :—These are :—

(1) LAND AND SEA BREEZES.—(*a*) *Sea Breeze* : Soon after sun-rise, a slight breeze (moist and cool) starts from the sea towards the lands ; by noon, it is very strong ; in the afternoon, it is cool ; and by evening, it ceases. (*b*) *Land Breeze* :—From after sun-set, a breeze blows from land towards sea ; it becomes strong at midnight and ceases towards morning.

(2) MONSOONS OF SOUTHERN ASIA—are periodical or season-winds produced by difference of atmospheric pressure and unequal heating of land and sea. When large portions of the earth-surface are heated at certain periods of the year only, periodical winds result. In the tropics, these are called monsoons (from 'mansin'=a season). The monsoons are usually divided into three groups : (*a*) N—E and S—W monsoons—found in the Indian Ocean and its coasts ; (*b*) N—W and S—E monsoons, found in the S. hemispheres ; and (*c*) West monsoon, found along African coast. In the Indian Ocean, monsoons are South-westernly from April to October and North-easternly from October to April. Similar periodical winds flow in Brazil, Peru, south part of North America.

(3). MOUNTAIN WINDS : (*a*) *Morning* or warm *valley* wind—which blows towards the upper slopes from valleys heated by sunrise. (*b*) *Evening* or cool *mountain* wind—which blows from mountains down into the valleys, rendering the latter cooler at night than the surrounding elevations.

(4). OTHER LOCAL WINDS :—(*a*) *Bora*—in the Adriatic, is a modified general polar current. (*b*) *Fohn*—a warm, dry wind in the north-east Cantons of Switzerland, probably, a modification of the equatorial current. (*c*) *Harmattan*—blowing over the Shahara towards Guinea in December to

February. (*d*) *Khamsin* or *Chamsin*—dry, sandy wind, blowing over Egypt in spring, during about 50 days ('Khamsin' meaning 50). (*e*) *Loo*—is a hot, dry, sandy wind blowing at noon during summer in Northern India. (*f*) *Mistrel*—of the Mediterranean coast of France, is a modified general polar current. (*g*) *Pamperos*—is the S.-W. wind of Brazil. (*g*) *Samiel*—of Syria and Turkey, is a hot, dry wind, probably from over the Shahara. (*h*) *Simoom* (=poisonous wind)—is, a hot dry wind arising from the deserts of Arabia. (*i*) *Sirocco*—of Sicily and South Italy is a S.-E. hot wind from Shahara. It is very enervating. (*k*) *Solano*—a S.-E. wind blowing from the Shahara into Spain.

IX. **Sunlight**.—It has a destructive action on germs generally and influences the formation of hæmoglobin (*a*) Its **Absence** (as during fogs &c.) gives rise to depression of spirits and in those who constantly reside in dark rooms, to tuberculosis and a low type of fever. (*b*) **Intense** sunlight (as in India) is productive of skin troubles (acute or chronic), injury to eyesight and insolation. The *heat* rays are the red ones, *light* rays, the yellow ones and the *chemical* rays are—blue, violet, and ultra-violet rays. The chemical rays are stimulant to the nervous system.

A European coming out to the tropics will keep good health by adopting the following plans: (1) Avoid *alcohol* altogether;—if tempted to take, take it after sundown. (2) Eat less *nitrogenous* food. (3) Avoid the *heat* of the sun, by sleeping in midday; by having red (instead of white) roads, planted with shady trees on both sides; by using khas khas or other tatties to doors and windows; by having electric fans; by painting inside of rooms rose colour and buildings, dark red; by having deep verandahs; by wearing clothing and hat of khaki or white colour externally and black or red internally; by having very broad brims to hats and felt spine-pad of yellow and red, sewn to the shirts. (4) Never *drink water* when very hot.

CHAPTER XXV.

CLIMATE : PRACTICAL APPLICATIONS.

Classification of Climates.—Climate can be studied from various standpoints of view as enumerated below :—

Academically : *Mathematical climate*—is the ideal conception of the heat, atmospheric pressure, humidity &c. of any place on the globe,—were this earth's surface completely round, even and dry. *Physical Climate*—has been defined already (see p. 332). **According to Situation :**—*Marine*—*i. e*, climate of sea-coast towns, *Mountainous* or *Inland*. **According to Degrees of Latitude :**—Tropical or Equatorial, Subtropical, Polar. **According to Mean Annual Temperature :**—Hot, Warm, Temperate, Cold, Polar. **According to Humidity** :—Humid and Dry.

For practical purposes, we combine one or more of the preceding, thus :—

I. Marine = Island and Coast

Humid and $\left\{\begin{array}{l}\text{warm}\\ \text{cool}\end{array}\right.$

Of *Mean* Humidity $\left\{\begin{array}{l}\text{warmer}\\ \text{cooler}\end{array}\right.$

Dry and $\left\{\begin{array}{l}\text{warm}\\ \text{cold}\end{array}\right.$

II. Inland—

Mountain or *Altitude*
Plain or *Lowland*.

Thus, it is principally based on temperature and humidity that climates are considered in practical life ; and they are grouped into three **seasons** :—(I). SUMMER = hot and dry. In India, it occurs between March and June. This period is practically rainless, with dusty, westernly winds. *The early part of it*—is stimulating to the weak and benefits cases of chronic dyspepsia, bronchitis, gout, rheumatism and phthisis. *During the height of it* headaches, apoplexies, thermal fevers, bowel-complaints and plague are common, and *extreme heat*—leads to prostration even of the robust. (II.) RAINY = hot and moist. In India, it is between June and October. This period is very unhealthy almost all over India and specially so in Bengal and bowel complaints, malaria and other fevers are rife, except in the hills of over 6000 ft. altitude. (III.) COLD = cold and dry in the earlier half and moist in the latter half, in India. It ranges from October to February. It is stimulating in every sense and *beneficial to* convalescents from malaria or liver trouble and, to some extent, to consumptives too. *It is trying for*—the aged, the children, the weak and those predisposed to rheumatism, catarrh or kidney troubles.

Selection of a climate.—In selecting a climate for an individual, attention should be paid BY HIS PHYSICIAN to the following points :—

I. **The patient :** (*a*) What are his *physical* and *mental* conditions? (*b*) His *constitutional* tendencies (phlegmatic, bilious, nervous &c.)? (3) His *circumstances* in life (affluent or indigent &c.)? [These items are weightier than the nomenclature of his disease or the ideal advantages that a place may afford. Think of the man, rather than of his disease or of the virtues of the place. Climate without comfort is worse than comfort without climate].

II. **The Meteorological and other Physical conditions of the place :** Ascertain the following facts regarding the place selected : (1) Geographical situation with reference to the equator and distance from the sea. (2) *Height* above sea level (3) Relative *humidity*. (4) Number of *rainy days*. (5) Sun *heat* and shade temperature—daily, weekly, monthly. (6) Presence or absence of any unpleasant prevailing *winds*. (7) Whether *shady* places are available for the invalid to sit.

III. **Sanitary Arrangements** of the place selected, as to (1) Pure *water* supply. (2) Sources of *air* vitiation (*e.g.*, mills, factories, objectionable trades, dust storms, marshes). (3) Good *drainage* of subsoil moisture. (4) Good *dietetic* arrangements. (5) Presence of a good local *doctor* and *dispensary*. (6) Easy *accessibility*. (7) Harmony between the invalid and the social and physical relations of the health resort. (8) Accomodation and situation of *the house* must be comfortable.

For climate to be of benefit, it is necessary ON THE PART OF THE PATIENT—(*a*) to *shift* from place to place, instead of being rooted to one spot for months; (*b*) to *have patience* and trust more to himself and to his conduct, than to the simple influence of any climate; (*c*) to *regulate* his life, habits, food, clothing skin-action, exercises, stimulants, travels, hours of rest and his recreations to the exact conditions of his ailment. The salubrity of a climate should not be an inducement to riotous living or to disregard of medical prescription.

Home Treatment vs. Climate.—Aside from local influences of Sanatoria, home treatment is almost as beneficial as treatment in sanatoria, provided patients remember that they are patients and health is their only concern and that they must conform rigidly to medical prescriptions as to (*a*) Food, drink and stimulants, (2) Exercise, rest and travel, (3) Clothing and management of skin and (4) pure and open air—in their room and out of doors—in all weathers. These four items make sanatoria and home-treatment alike successful or otherwise,—according to how they are carried out.

Elements of a Good Climate—are its *changeableness* within moderate limits—so that, the constantly changing external agencies may *stimulate* all the organs and tissues of the body to activity : hence, "agreeable" climates are often not "good" climates and disagreeable climates are often the most beneficial ones ; hence, too, a climate that is good for the healthy is often bad for the weak or diseased. Climates thus, are broadly speaking classified as (*a*) **Stimulating** or **bracing,**—where the temperature, moisture, light, electricity, wind and atmospheric pressure are *constantly* but moderately *changing*,—thereby promoting metabolism. Here [Mountain-tops], the *air* is cool, and dry, and moderate amount of wind freely blows and sunheat is great. (*b*) **Sedative** or **Relaxing.**—Where the atmosphere is warm, equable, still, moderately humid, and where, for long periods in the year, the same degree of bright sunshine exists and moderate, dry, warm wind blows. Those who are *torpid* (but with fair residue of vigour) benefit better by a stimulating climate ; the *bilious* by a sedative ; the *erethic* (i.e., abnormally excitable) by a sedative or marine ; and the *lymphatic* by an inland, climates. The very young, the very old, the constitutionally delicate, the sufferers from heart disease, emphysema, bronchitis, and the convalescents benefit by a sedative climate.

Influence of the components of climate.—We study the effect, on health, of the individual components of the climate of any place :—

I. Purity of Air.—Persons suffering from *skin* troubles or *ulcers* or from certain species of *fever* or other *constitutional diseases*, should avoid a climate where the air is not free from floating impurities. For them, sea voyages or residence on high attitudes that are sparsely inhabited—are the best.

II. Temperature :—As temperature has *stimulating* or *depressing* influences on the body, climatically, it is very important, with reference to any particular locality, to know these temperatures : (*a*) mean *annual*, (*b*) mean of every *season*, (*c*) mean of every *month*, (*d*) the maxima and minima of each *week* and of *day* and (*e*) how the temperature is *distributed* between the various hours of the day. An exact knowledge like this alone can enable us to judge—(i) of the *suitability* of climates to persons in delicate-health and (ii) the best *time* when to send patients to health-resorts.

EFFECTS OF HEAT : (·1) *When heat is moderate*=diminution of oxygenation of blood and of metabolic activity (∴ less urea, less respiratory CO_2, lessened appetite and respiration), hence—less food is required, or, with the same amount of food as in winter, the body-weight increases. (2) *When heat is excessive*—depression of muscular, nervous, digestive, respiratory, urinary and circulatory activities, and of the formation and destruction of tissues, increased cutaneous activity : hence, Europeans* when transferred to climates where the mean temperature is 20°F higher than in their own homes, lose vigour and die out within a few generations unless crossed with the natives. [*Sunstroke* is not the effect of pure heat ; for, it is rare—alike in high elevations, and on the high ocean, where the air is respectively dry and moving. The degree of moisture and the electrical and moving conditions of the air render it tolerable or otherwise—irrespective of the heat of it. A shade heat of 90° to 100°F is overpowering]. Climatically—we have little to do with *high* temperatures; at *moderate* temperatures (55° to 70°F), those who are permanently delicate or suffering from chronic diseases or are temporarily weakened, as well as persons with certain respiratory and renal affections benefit very well; they gain in weight and mental activity and are less prone to diseases. *Equable* temperature throughout the year—benefits delicate patients.

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* **Effects of migrations** : (A) *From cold to hot countries* : After a brief stimulation of respiration and circulation and some rise of temperature, digestive, renal, hepatic and mental functions become torpid, the skin acting freely to keep the body cool. (B) *From hot to cold countries* : There is a sudden check of cutaneous activity, with corresponding congestion of internal organs—hence, a liability to kidney diseases and consumption. (C) *Gradual* changes—from hot to cold countries or vice versa are not at all injurious and establish tolerance.

II. Effects of low temperature.—As a rule, continued and "*severe*" cold is never sought after; hence, we consider only "*temperate*" and moderate cold. Cold is almost invariably associated with either much moisture and wind (which cause greater heat-loss) or dense *fogs* (which diminish light, check the pulmonary and cutaneous excretions and is associated with imperfect combustion of fuel and other injurious substances floating about). Granted that sufficient food and raiment are available, *cold is bad for* the *baby* and the *old*; those who are really nervous, weakly or *delicate*, develop catarrh, rheumatism, constipation, biliousness, irregular menstruation or amenorrhoea and suffer from mental or physical torpidity. Climatically, therefore, cold *benefits* healthy and vigorous individuals as also those who suffer from—sluggish venous circulation, intestinal torpidity, bodily and mental hebetude (i. e., retarded tissue change). Moderate cold (54°—72°F) is beneficial to the weak and debilitated whose nutritive functions are thereby stimulated.

III. Humidity.—Generally speaking, by day and by night, in the shade as in the sun, humidity tends to render a climate *equable*. [*Relative humidity*—imparts a more or less quantity of moisture to the skin. (i) In moist and warm air, if there is no wind, skin remains moist with sweat, which soaks into the clothes ; any sudden depression of atmospheric temperature under such circumstances, leads to contraction of sudden chill. Moist warm temperature leads to bowel complaints, diminished muscular appetite and muscular activity, soothing of the respiratory mucous membrane and growth of low organisms—like tubercle bacillus—and therefore to increase of phthisis. (ii) Moist cold air leads to rheumatism, catarrh and renal mischief] (i) EXCESSIVE humidity is injurious both to the sick and healthy. (ii) WHEN EXCESSIVE HUMIDITY IS COMBINED WITH HIGH TEMPERATURE and still air,—it increases the effect of the heat and produces—(*a*) hyperactivity of kidneys (*b*) diarrhœa, dysentery and bleeding from piles ; (*c*) epistaxis, and, in cases of phthisis, hæmoptysis ; (*d*) excessive protozoal and hæmatozoal diseases. (iii) EXCESSIVE HUMIDITY PLUS LOW TEMPERATURE—causes fog and therefore the climate is less exhilerating. [MISTS—are always unhealthy, as they not only check cutaneous and pulmonary excretions but cause us to inhale products of incomplete combustion of fuels. Hence, the meaning of knowing their frequency, nature and duration, in reference to a place. CLOUDS—obscure and modify the sun's rays and thereby cause depression of spirits, loss of appetite and other dyspeptic symptoms. RAIN-FALL : (i) Its advantages are that it purifies and refreshes the atmosphere and decreases relative humidity : hence, in some persons, it leads to increased energy. (ii) Its disadvantage is that it prevents one from going out. Hence, climatically, it is more important to know the number of rainy days and the hour during which rain falls (as preventing one's outing) than the total rain-fall of a place. Considerable rain-fall per se has no deleterious effect on the system, but may cause malarial increase on plains]. (iv) DRY AIR (even the driest air contains 55% moisture)—is beneficial to many cases of chronic bronchitis, phthisis and Bright's disease. (v) DRY WIND

WITH WARMTH—is beneficial to gouty and rheumatic patients. [Degree of *Absolute humidity* (=actual moisture in the air)*—by causing greater loss of H_2O by breath, leads to diminished expectoration and hence, dry climates are bad for *pulmonary* cases: in dry and warm air, the skin parts with much moisture; in dry and cold air, the lungs do so. (*f*) SNOW.—While frequent melting of snow leads to catarrh, the stay of snow for long periods without melting has these *advantages*:—(i) the air remains pure, dry, bracing and dustless; (ii) the reflected rays of the sun are increased; hence the atmosphere is rendered comparatively warm; and (iii) as it prevents the heating of the ground, strong winds are absent.

For healthy individuals in temperate climates, an average 75 % saturation is the humidity best liked. Humidity per se has little ill effect on health.

Winds: (*a*) *Continual calm* is injurious, specially, if associated with impure air and warmth. (*b*) *Moderate* wind is healthy to delicate individuals. (*c*) *High and Cold* winds are very injurious to delicate persons.

Marine Climates—refer to climates of (*a*) *islands* of moderate size and (*b*) sea-*coast* places. They are **governed by** (*a*) their distance from the equator, (*b*) effect of sea-currents and (*c*) of land wind-currents. Speaking generally, marine climate (*a*) is free from *floating* impurities; (*b*) is *humid* and (*c*) is *equable*—both seasonally and diurnally.

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* *Absolute humidity* is expressed either in grains per cubic foot of moisture present, in terms of the tension in inches or mm. of mercury exerted by the moisture in the air. It is greatest near the equator, least near the poles (as the warmer the air, the greater is the amount of moisture it can absorb), greater on sea than on land, on the sea shore than inland, in summer than in winter, by day than by night, at sea level than at great elevations'. [*Relative humidity*=absolute humidity × 100 and ÷ by saturation].

Whom it benefits :—(*a*) *A healthy person*—gets increase of tissue-changes (∴ increased appetite and greater mental and bodily changes) and sounder sleep. (*b*) A *weak* person in *sound* health—improves in his blood, muscle and nerve-power and the condition of his skin (∴ liability to catarrhal and rheumatic affections is diminished). (*c*) *Scrofulous or tubercular children*—benefit immensely by sea-bathing, provided, they have good digestion, assimilation and power of resistance. (*d*) Cases of—neurasthenia, anæmia, chlorosis, amenorrhœa, insomnia, convalescents from acute affections, early and non-active cases of phthisis, malarious cases, cases with liver disorders, winter coughs and bronchial catarrh—are all benefitted.

It is injurious to—(i) persons of weak heart with passive congestion of liver or other organs; (ii) sufferers from asthma; (iii) skin affections; (iv) confirmed dyspeptics; (v) the gouty; (vi) the hysterical; (vii) the bilious.

Sea Voyage.—The sea-air is pure and contains ozone, bromine and iodine. A sea-voyage, provided the patient is able to stand it, is another form of continuous open-air treatment. It is BENEFICIAL IN CASES OF—phthisis (early stage), scrofulous children, dry form of asthma, chronic bronchitis, chronic laryngitis, non-organic nervous conditions, convalescence from malaria, low fevers, hepatitis, dysentery (subacute or chronic), diarrhœa. IT IS INJURIOUS—when the voyage is prolonged (*i.e.* there is lack of exercise) or when the sea is rough; it is injurious also to the weak, the aged, the bilious, the pregnant, those who suffer from dilated heart, hæmoptysis, epilepsy, advanced phthisis, greatly enlarged liver. Sea voyages should be so arranged that *cold season* may be spent in warm regions and vice versa. *In the tropics*, the evenings are damp, hence chills may be taken on exposure on board.

As the temperature and humidity of marine climates have different effects according to their quantity, we give each separately below :—

Humid, warm, marine climates (say, 40°—80° F.)—are *sedative* and even *relaxing*. Their GOOD is, that they allay chronic laryngeal and bronchial irritation (and therefore benefit cases of chronic catarrh of larynx and bronchi) ; in emphysema with scanty expectoration ; and incipient phthisis occurring in an erethic subject who can bear sea-voyage ; their BAD is that they render worse persons who have a tendency to copious discharges from the mucous membranes and to atonic dyspepsia. Most of the INDIAN sea-coast places are warm and humid and being near marshes, rivers or alluvial soils, are unhealthy—giving rise to malaria and bowel-complaints. Sanitary towns like Madras, Surat, Bombay, Waltair, Mangalore, Cochin, Mercara, Karachi, Trincomali, Colombo, Moulmein, Rangoon, Muslipatam, Puri &c. should be selected for residence before the monsoons or after the rains, by those suffering from recurring malaria, asthma, dry bronchitis, liver troubles, or phthisis.

Humid, cold marine climate,—not resorted to therapeutically.

Warmer Marine Climates, with mean humidity.—They are GOOD for cases of neurasthenia, ill-defined cachexia, tardy convalescence from pneumonia and pleurisy and chronic cases of phthisis with a tendency to congestion or inflammatory complications. They are bad for the lymphatic and bilious and those with kidney or liver affections.

Colder marine climates with mean humidity.—They are stimulating and cases of atonic gout and rheumatism, atonic catarrh of mucous membrane, atony of skin and tendency to catching cold—are benefitted.

Dry, Warm Marine Climates are useful for—those of delicate constitution or organization; those who have long resided in the tropics; those who are anæmic, rheumatic, gouty, scrofulous; those suffering from the remains of pneumonia and pleurisy, from chronic diarrhœa or chronic respiratory-passage catarrh; chronic but not too erethic form of phthisis; persons who have a tendency to phthisis, but who must, at the same time, live in towns.

Inland Climates.—They are roughly divisible into *Mountain* and *Plain* climates—under which we consider them.

A. Mountain Climates.—DEFINITION.—(*a*) As several factors make up climates, on mountain *chains* we shall look upon only those elevations as possessing mountain-climate, where the vegetation assumes *Alpine character*. Hence, places at altitudes of—10,000 ft. on the Himalayas, 6,500 ft. on the Alps and 1,500 ft. in some places in Germany—all possess mountain climates. (*b*) *Isolated* mountains and small mountain groups arising from plains, away from the sea, possess a mountain climate at less elevations than mountain chains.

PHYSICS OF MOUNTAIN CLIMATE;—(1) *Air is rarefied*; at an altitude of 16,000 ft., the atmospheric pressure is half of that at sea-level. (2) *Temperature*: On an average, each elevation of 512 to 556 ft. gives a decrease of temperature of 1°C. (=1°8 F.) But—(*a*) In winter, the higher elevations are comparatively warmer and have a lesser range between summer and winter temperatures. (*b*) During early afternoon, the valleys are warm; but after sunset, valleys are cooler. (*c*) Latitudes, seasons, aspects—also affect the temperature. Thus, their situation in the tropics, the proximity of warm oceans and the periodical winds make the Himalayan climate different from that of the Alps or Andes. Climates with much difference in the morning and evening temperatures (as on tablelands or valleys) are injurious to delicate invalids. (3) *Humidity*: Absolute humidity is less in higher rigions. Relative humidity is variable. In the rooms, air is often drier than in the open. Thus, it has been found that on a certain mountain, while the outside temperature was 18°F with 60% humidity (=0·7 gr per cub. ft.), inside the room, the temperature was 60°F and humidity 25 to 35%. (*c*) Clouds are more frequent in medium elevations and rare at higher elevations. This is a very important factor in relation to action of skin and humidity of the inspired air. (*d*) Fogs are rarer in higher regions. (*e*) Rainfall depends on relation to moist winds. It is very great on the south-eastern side of the Himalayas and very scanty on the south-western side, particularly in the valley of Kashmir. (*f*) Moisture of the soil—depends on local circumstances. [Ravines and deep valleys are unhealthy and in India, malaria is found up to 6000 ft. altitude.] (4) *Purity of air* (as regards dust and organic matter) depends on the inhabitants. As a rule, in the higher regions, putrefaction does not readily occur ; air there, therefore, is practically aseptic ; but, where overcrowding of buildings and populations occurs and buildings are allowed to obstruct sunlight and air, at least on the principal throughfares, and when social entertainments are freely indulged in, and manufactories and dusty roads abound, air cannot remain pure. (5) *Ozone*—is abundant. (6) *Wind* (See Mountain and Valley winds, p. 345) : The movement of air is generally increased in summer and decreased in winter. But much depends on the face of the mountain—according as it is sheltered or exposed. (8) *Sunheat.*—In higher elevations, sunheat is greater than in lower situations—greater particularly immediately after sunrise. Hence, the difference between the sun and shade is greater at higher altitudes. (8) *Sunlight*– is very strong.

ADVANTAGES OF MOUNTAIN CLIMATE. *Mountain air is*—pure, dry, cold, with great sunheat and is very thoroughly ventilated ; it is aseptic, rarefied and has curative effect on ulcers. It is stimulating and bracing and best benefits constitutions possessing certain amount of energy and power of accomodation. *General Metabolism* is stimulated ;—hence, increased appetite, improved mental power, enriched blood] improved muscular and nervous power, gain in weight. *Sleep*—is sounder and a shorter period of sleep is more refreshing than a longer period on the plains. *Respiration.*—Circumference of chest increases. Ulcerative and inflammatory processes in the respiratory passages heal rapidly. Inspirations become deeper. *Skin* : Tendency to chills and colds diminishes. *Heart.*—Its beats temporarily increase in force and number. [Tendency to hæmorrhage occurs at altitudes much higher than those selected for therapeutic purposes].

SUITABLE FOR—cases of bronchial asthma (uncomplicated with bronchiectasis, emphysema or heart trouble), chronic catarrh of throat and air passages (with much secretion), imperfect chest expansion, tendency to phthisis or first stages of chronic phthisis, scrofulous affections ; malarious or other cachexias, anæmia, hydræmia, leucocythæmia, tardy convalescence ; atony of functions of skin, liver, stomach etc. from overwork, exhaustion or prolonged town-life ; climacteric conditions ; weakness of skin with profuse perspiration.

UNSUITABLE to cases of—Apoplexy, aneurism, asthma, atheroma (real or with only a tendency), gout, rheumatism, tonsillar, pharyngeal or laryngeal inflammation, emphysema (if advanced and accompanied with bronchitis), laryngeal and intestinal tuberculosis ; kidney and heart-diseases,—fatty or dilated ; convalescence or suffering from dysentery, epilepsy, mental aberrations (with excitement), extremes of age, constitutional weakness (with inability to bear changes of temperature, liver cirrhosis or abscess, neuralgia, acute pleurisy, bronchitis or pneumonia, advanced phthisis.

HOW BEST TO USE THE CLIMATE : (1) Avoid—windy aspects, narrow rooms, crowded houses, all places of amusement where many people congregate. (2) If there are pine forests, lie on hammocks or sit beneath shades. (3) Even if it snows outside, sleep with doors and windows open. (4) Winter is often the best season when phthisical patients can derive the greatest good, provided they start a little before the actual onset of winter and as spring is often damp and windy, the patients should remove before its onset.

Phthisis and Mountain Sanatoria :

Cases suitable are : (1) Those with tendency to phthisis. (2) Early stages of P. P. (one or both sides) with limited infiltration, with or without cavities, high fever and tendency to hæmoptysis, chronic catarrhal pneumonia of apex. (2) Remains of pneumonia or of pleuritic affections (with or without exudation). (5) So-called caseous deposits, resulting from catarrhal, pleuritic or pneumonic affections. (6) Chronic bronchial catarrh of lower lobes. *Cases unsuitable* : (1) P. P. (in whatever stages) in erethic constitutions ; (2) advanced P. P. ; (3) still progressive P. P. ; (4) abdominal phthisis.

(B) **Lowland or Plain Climate**.—If we except marine climates, there remain only two or three features that deserve attention in regard to the plains :—DESERT CLIMATE.—It is rainless, dry, transparent, transcalent, very hot in the day and very cool and dewy at night. The heat permits great exertions without causing lassitude or perspiration. The desert climate is stimulating and exhilerating. (See p. 338) *Cases benefitted* are—those of scrofula, chronic catarrhal conditions, phthisis, gout, rheumatism, albuminuria, emphysema with much secretions. RIVER TRIPS—some of which are invigorating, specially, if the patient is a good sailor and has halting places. (See Sea Voyage p. 355). Some SPECIAL PLACES—like Lake districts etc.—may be healthy.

Climates with reference to Diseases :—

Asthma (*a*) *Due to catarrhal conditions* in young individuals—high elevations. (*b*) *Due to emphysema or Heart* *disease*—(i) in erethic subjects—equable, sedative climates ; (ii) in relaxed constitutions—dry, warm, stimulating climates. (*c*) *Nervous*—try respectively, elevations, stimulating and sedative climates.

Anaemia & **Chlorosis.**—Dry and cool places, where patients can remain out-of-doors longest *e.g.*, (*a*) in winter—sunny and warm sea climates ; (*b*) in summer—mountains, woods and the sea. In leukæmia,—dry, cool, lowlevel climate. Where there is a tendency to bleeding from nose, genitals, lungs &c., select a dry, desert climate.

Climacteric (in men and women).—Repeatedly change to localities where spirits are exhilerated and mind is congenially occupied.

Senility or old age—demands a mild, sunny (warm) and moist winter or a spring climate [Senility of individual organs like heart, arteries etc. is incurable ; but can be managed to the benefit of the patient by climates].

Bronchitis (chronic) :—Where cough is not much but secretion is profuse—warm, dry climates. Where cough is much but secretion is less—warm, moderately moist climate. **Winter Cough** requires the winter to be spent in a sea coast that has equable warm, dry climate.

Convalescents from acute diseases—require to be "changed" in two stages ; in the first instance, they should move to places nearest home, where chill, unaccustomed food and fatigue are eliminated ; thereafter, they can move to sea or its shores and to mountains.

Diabetes—requires a dry cool climate.

Dyspepsia—Erethic patients require sedative, marine climates ; torpid constitutions require stimulating climates (mountain and sea). Plethorics require dry, low level inland or hill but not sea. Travelling and spas are additional helps.

Heart troubles—fare badly in very cold or at high elevations; they do well in winter in warm, dry, flat, level regions; and in summer, at moderate elevations or seashore.

Bright's Disease & Nephritis—require that the air and soil shall be warm, sunny, dry and free from disagreeable atmospheric changes—so that the skin may act abundantly and undisturbed. Humidity is of secondary importance to temperature and wind—but the locality should be conducive to an out-of-door life, the year round.

Liver (torpid) —Hill stations or sea voyages.

Excitable and Neurotic people :—Warm and moist climates—*e.g.*, river valleys, sea coasts etc.

Malaria—When active fever is gone, but patient is only anæmic,—hill over 6000 ft. (in the tropics). When liver or other organs are congested—cool, dry, sunny marine or inland places. When degenerative or fibroid changes occur in viscera —warm, dry, inland climate.

Mental aberrations—require climates that afford social and other recreations and occupation—as in cases of mountains.

Phthisis—For first and second stages of mild or non-febrile cases, select hills 2000 ft. in temperate, and 6000 ft. in the tropical, places. For incipient cases, sea-voyages in warm but not very hot regions. For cases with hæmoptysis, dry coast climates. For cases with bronchitic symptoms, desert climates. For fibroid phthisis, warm, equable climate. Each patient should shift according to his local and general conditions and as phthisis ultimately leads to brain degeneration, no patient should be left to himself.

Rheumatism & Gout—require dry, warm, sunny climates.

Scrofula—requires sea shore and sea-bathing. But keep out cold. Mountain climate is good for those with scrofulous skin diseases or ophthalmia.

Syphilis : Dry and moderately warm climate. Avoid the cool hills.

CHAPTER XXVI.

(A). FOREIGN HEALTH RESORTS.

Marine, Humid : (1) *Warm*—Madeira Islands (Funchal), Azores, St. Michæls, S. Hemispheres Friendly (Tonga) islands, Society islands. (2) *Cool*—Hebrides, Orkneys, Shetland islands, Faroe Is., Iceland, Auckland Is., Falkland Is.

Marine, of Mean Humidity : (1) *Warm*—Cadiz, San Lucar, Gibraltar, Valentia, Ajaccio, France S. W. Coast, Sicily, Biarritz, Palermo, Catania, Acireale, the Eastern Reviera, Venice, Lesina, Corfu, Zante, Patras, Crimea, Cyprus, New Zealand, N. Plymouth, Wellington, Nelson, Mogador, Tangiers, Algiers. (2) *Cool*—Great Britain and Ireland, Coasts of Germany, Norway, Sweden, Tasmania.

Marine, dry, warm : the Western Reviera, Southern Italy, Salerno, Malta Is., Balearic Is., Mediterranean coast of Spain, Smyrna, Athens, Australia (Sydney), Melbourne, Tasmania, Alexandria, Port Said, Cape Town, Natal Colony, Port Elizabeth, Durban, Cairo, Assouan, Helouan, Bikra, Hammam R'Hira, Hammam Meskoutan, Algiers.

Mountain : Alps (Davos Platz, St. Moritz, Samaden, Lower Engadine, Prattigau, Cantons of Berne, Valais, Vaud, Appenzell &c.), Andes, Rocky Mts., Cordilleras, Minnesota State, Orange Free State, Griqualand West, Transvaal, Bloemfontein.

Deserts : Nubia, Ismalia, Helman, Cairo.

(B) PLACES OF HINDU PILGRIMAGE.

These are invariably sanitaria, and, although, some of them are not so healthy now from neglect or from artificial causes, most of them yet are so. It was probably with a view to secure periodical excursions into healthy places, that pilgrimage was made compulsory, specially during the declining years, when a boat journey or a hill-climb was likely to invigorate health. Most of the pilgrim spots are on hill tops or on banks of navigable rivers. The famous ones are : Ajodhya, Allahabad, Amarnath, Amarkantak, Antravedi, Aroonachal, Badarikashram, Baidyanath, Benares, Bhimghora, Bhubaneshwar, Brindaban, Chandranath, Chidambaram, Conjeveram, Dwarka, Gangotri, Gauhati, Gokarna, Gaya, Haridwar, Hrishikesh, Jwalamukhi, Kailas, Kankhal, Kedarnath, Kurukshetra, Mayavaram, Muttra, Nassik, Panchabati, Pashupatinath, Puri, Pushkar, Rameshwaram, Ramnad, Sarnath, Sitakund, Tanjore, Tarakeswar, Thaneswar, Trichinopoly, Tribeni.

(C) SPRINGS IN INDIA.

These have not been so well studied as those of Europe and their therapeutic value to us is unknown ! We tabulate below those that have been known, in the hope of stimulating research work on this new subject. Springs that have a (T) appended to them are thermal and the names of districts or well known towns, in or near which, the springs are situated, follow the names of the places where the springs are :—

Sulphuretted.—*Arowlee* (T)—in Konkan, *Badrinath* (T), *Bakeswar* or *Kana*, *Bhatrachalam* (T)—on the Godavery, *Barabar hill* or Patalganga, *Baramula* in Kashmir, *Bishisht* (T)—in Kulloo, *Bukh Ravine* (T)—in Punjab Salt Range, *Buni Bukleswar* (T)—16 miles S. W. of Suri in Dt. Birbhoom, *Chihalee Pass*—below Kalabagh, *Chittoor* (T)—Madras Presidency, *Ellora*, *Gazi Peer* (T)—in Sind, *Gwalior*—a well, *Hazaribagh* (T)—27 miles north of it, *Islamabad* in Kashmir, *Jwalamukhi* (T), *Joara Buri* or *Jharia pani* (T)—near junction of Barakar and Damodar rivers, *Jubba*—in the Punjab Salt Range, *Landour*—below it, *Lasundra* (T)—Dt. Kaira, *Lousah*—in Noorpur, *Lukhee Pass* (T)—near Sewan, *Maha-*

deo Hills (T)—two springs at their base (Nerbudda country), *Manikaran*—20 miles N. E. of Sultanpur, *Mittah*—near Ismail Khan, *Nunbil* (T) in Dumkah, *Pampur* in Kashmir, *Rajagriha* (T), *Peer Mangal* (T)—in Sind, *Sitakund* (T) in Monghyr, *Somnath*—in the temple, *Sonah* (T)—30 miles from Delhi, *Tantloie* (T)—near Jorya Buri, *Taptapani*—in Dumka (T), *Tatapani* (T) in Serguja, Chhotanagpur, *Unabedev* (T)—in Khandesh district.

Saline.—*Bhubaneswar*—in Puri district, *Doozeekoostuck* (T)—in Sind, *Hyderabad*—near it (in Deccan), *Lahard khad*—on the Sutlej, above Roopoor, *Lukhi Pass* (T)—near Sewan, *Mukhdoor Rushed*—in Multan, *Ooch*—in Sind, *Salt Range* in Punjab : throughout it. specially the *Sumoondur* and *Kullur Kuhar* lakes), *Shahpur*—near Thang, *Suryyakund* (T)—on Grand Trunk Road, *Teoah*—in Kangra district.

Brine occurs in—*Bikanir*, *Cachar hills*, *Jeysalmir*, *Peer Mangal* (in Sind), in many springs in the *Salt Range*, in an old spring near *Tejpur* in Assam. Also in the Sambhar lakes in Rajputana.

Alkaline water occurs in kari water or soda water wells in *Ajmir*, in well at *Jwalamukhi*, in the *Loonar lake*—50 miles from Jalna and at *Mean Meer*—near Lahore.

Aluminous water occurs in well below Landour.

Iodine—occurs in well at *Arlun* in Kangra, at *Jwalamukhi*, and at *Thunga Bara*—near Haripur in Hazara district.

Iodide of Potash—occurs in well at *Jowali.*

Lime—at *Kye* (T) and *Peeth* (T)—both in Hala mountains, in several springs in the *Muree hills*, near *Sunjabundia* (T) in Kurnool district.

Silicious—in *Burare* and *Bheem Bhand*, *Kurruckpur hills* (T)—in Monghyr district.

Chalybeate : *Bangalore*, *Bukh Ravine*—in Salt range, *Chihalee*—on west bank of river Indus, *Dalhousie*—in Chamba State, below *Landour*, at *Munnee karn*, at *Nagkonda*—in Simla hills, *Raman droog hills*—near Bellary, on *Rangeet river*—in Darjiling district, *Rangnoo* river—4 miles east by north of Darjiling town, *Rhotas*—near Jhelum.

Thermal springs with no important ingredient but probably carbonated : In *Alwar state*—one is situated 15 miles west by south of Alwar and another 20 miles north-east of Jeypore ; at *Badrinath* in Dt. Gharwal ; near *Bagni* river, in Panna state (C. I.) ; near *Booktee* (Punjab) ; near *Buxa* (Jalpaiguri) ; at *Byorah* ; at *Deyrah*—in N. Sind ; at *Gangotri*—in Gharwal district ; at *Giriak*—north by east of Gaya ; at the base of *Hala* Mountains (Sind) ; at *Hatbulleah*—between Rajmahal and Suri ; at *Juggun* in N. Sind ; at *Jamunotri*—in Gharwal ; near *Jauree*—in Punjab ; at *Katkamsandi*—on old Benares Road ; at *Kair* in the Deccan ; at *Kedarnath*—in Gharwal district ; at *Keljharni*—between Rajmahal and Suri ; at *Kulat* in Kulloo ; *Lakarakund*—21 miles S. W. of Suri (Birbhoom) ; at *Machery* ; at *Mahardo*, between Rajmahal and Suri ; at *Manikarn*—in Kulloo ; at *Mhar*—in Surat ; at *Nowbhil*—between Rajmahal and Suri ; near *Nupta*—in Sutlej Valley ; *Oonee*—central range in Kattywar ; *Oonoopdeen*—in Satpura range ; at *Paharpur*—on the Kharakpur hills, in Monghyr district ; along the *Parbati* river in Kulloo district ; at *Pinarkoon*—in Ramgarh, Hazaribagh district ; at *Pir Magan*—13 miles from Karachi city ; *Rahiagiri Mat*—in Surat ; at *Rajgir*—N. E. of Gaya ; on *Rangeet* river—in Darjeeling Dt. ; at *Sitakund* in Monghyr town and also near Chittagong ; at *Silol*—in Kangra Dt. ; opposite *Sonee*—on bank of the Sutlej ; at *Soonoopdeen*—on Satpura range ; on the lower range of *Suleiman* mts. ; at *Tantloie*—16 miles N. W. of Suri ; at *Urjunna*—in the Deccan ; at *Utteer*—30 miles from Puri.

Petroleum : in *Assam*—at Tejpur and five other places and at Sylhet ; at *Algud* ravines—on the west bank of the Indus ; at *Dooloo* (east of Gogra) three springs ; at *Jubba*—north side of the salt range ; at *Jwalamukhi*, at *Kaffir kot*—on the west bank of the Indus ; and in *Burmah*.

(D) CLIMATE OF SOME INDIAN DISTRICTS :

With a view to stimulating enquiry, the following connected bird's eye view of the climate of the important Indian districts has been compiled. It will furnish Indian practitioners with a workable guide, when recommending climates to their patients :—

Allahabad (U. P.) *: Soil* : North is purely alluvial ; south is composed of black soil, interspersed with rocky hills. *Temperature*—has been known to rise even up to 120° F (dry heat). *Rainfall* : 37 in. The city Allahabad is well drained and situated at the confluence of the Ganges and the Jumna. The climate is healthy. Plague is endemic.

Almora (U. P.) *Soil* : It is a part of the Himalayan mountains. *Elevation* 4000 to 23,000 ft. *Drainage*—good. *Rainfall* : 40 to 80 in. *Sanitarium* : Almora Town, 8596 ft. above sea-level.

Balaghat Dt. (U. P.) *Soil :*—Mostly hills and elevated plateaux, generally sandy. *Elevation :*—About 2000 ft above sea-level, except a part which is only 1000 ft. *Rainfall* : 62 inches. *Climate* : Sharp frosts in December and January. *Diseases* : Malaria. Mica particles present in water produce gastritis.

Balasore (Orissa). *Soil :* Alluvial. The northern portion not healthy (malarious), the rest is healthy. *Rainfall :* 60 inches. *Temperature :* 44° to 116°F. Cyclones are frequent. Summer is breezy—therefore seldom oppressive. *Diseases endemic :* Cholera, elephantiasis, hydrocele, leprosy. *Healthy Stations :* Balasore, Bhadrak, Chandbali, Chandipur.

Banaglore (Mysore). *Soil* :Red fertile loam. The centre, the south and the east are open and undulating ; the west, rugged and broken, with hills rising to 4500 ft. above sea-level. *Climate*—salubrious. *Temperature* : 69°F to 80°F. *Rainfall* : 35 in. *Diseases* : Malaria. *Healthy station* : Bangalore city.

Bankura (Bengal) :—*Temperature* : 80°F to 115°F. Winter is dry, windy and bracing. *Rainfall :* 55·26 in. *Western part* is healthy, well drained and dry ; *Eastern*—unhealthy and malarious. *Resorted by*—sufferers from "fevers".

Baroda (Guzrat). *Soil* : Mainly alluvial, the number of hills being very small and the highest of them being only 888 ft. high. Soil is red in the north and black in the south. *Temperature* : 50° to 110°F. *Rainfall* : 38·1 in.

Benares (U. P.) : *Soil*—is a part of alluvial valley deposited by the Ganges. *Drainage :* Part to the east of the Ganges is not well drained; on the west, the soil is not so liable to water-logging. *Rainfall*: 40 in. *Temperature*: 60°F to 92°F. *Winds*: In summer, west winds blow intermittently; during rains, a constant east wind prevails. The climate is moist and relaxing like that of Bengal, except in cold season.

Betul (C. P.) *Soil:* Hilly and undulating country with a thin sandy soil. *Elevation:* wholly a plateau, 2000 ft. above sea level, one plateau rising to 3789 ft. *Rainfall*—46 inches. *Seasons:* Climate is cool and healthy. In winter, temperature falls several degrees below freezing point.

Bahawalpur State (Rajputana). *Soil*; Alluvial, deep mass of sand, with deposits of amorphous sulphate of lime. The surface is a mass of sand-dunes, rising at times to 500 ft. *Rainfall*: 5 in. *Temperature*: 60°F to 103°F. *Diseases*: Stone, scurvy, malaria.

Bhagulpur (Bengal): *Soil:* North half is in most part liable to floods and is alluvial sandy plain, and marshy in places; South half is in parts hilly and liable to inundations. *Temperature*: 62°F to 97° F. *Rains*:—59 in. *Healthiest months*—February, March, July. *Diseases* cholera, malaria, worms, P. P., goitre.

Bikaneer State (Rajputana). *Soil*: Sandy on the N. W. and N., being part of the great Indian desert. Surface of the country is full of undulating sand hills 20 to 100 ft. high. There are one or two rocky hills, the highest being 600 ft. high. There are two salt lakes. *Climate*: Dry and healthy. *Temperature*—is characterized by great extremes; the average mean of temperatures at the Capital city is 81°F. *Rainfall*: 12 in.

Birbhoom (Bengal): *Soil*: South-east and east are alluvial; west—is reddish brown gravel and rock. The soil is porous and the rivers (Ajay &c.) afford good drainage. *Rainfall*: 55·77 in. *Climate* is dry, mild and healthy. *Diseases*: Fever epidemics occasionally. This district and Bankura contain more lepers than any other districts in India.

Bogra (Bengal). *Soil*: It is a dead level plain with slight inclination towards south and south-east. The eastern portion is low-lying and subject to inundations yearly. *Seasons*: It is comparatively healthy except during the rainy seasons. *Rainfall*—66·26 in. *Temperatures*: 64° to 84°F. *Diseases*: Malaria, bowel complaints, scrofula, goitre, hydrocele, bronchitis, rheumatism.

Ahmednagar (Bombay). *Climate:* on the whole, is genial. Cold season is dry and invigorating; hot dry wind blows from March to May. *Temperature:* 45° to 106° F. *Rainfall*: 26 in.

Agra (U. P.)—Like Muttra.

Anantapur (Madras). It forms a part of the northern extremity of the Mysore plateau and slopes from south to north from 1000 to 900 ft. *Climate* is one of the driest in Madras Presidency and healthy. *Rainfall*—scanty,

Burdwan (Bengal). *Soil*: East—is alluvial, water-logged, swampy jhils abounding towards extreme east; West—is barren, rolling, rocky, laterite soil, with hillocks here and there. The western half beyond Galsi is dry and porous. *Healthy Towns*: Asansol, Raniganj. *Rainfall*: 57·54 in. *Diseases*: Burdwan district was the original home of the Burdwan fever (Leishman-Donovan infection?)—now died out. In its eastern half, malaria is rife. Until 1862, Burdwan town was regarded as a sanitarium.

Bara Banki (U.P.). *Soil*: alluvial; it is an almost level upland plain, sloping gently from north-east to south-west. *Climate* (excepting the low-lying tracts near the Gogra)—very healthy. *Rainfall:* 40 in.

Basti (U.P.). *Climate:* mild and healthy. *Rainfull:* 49 in.

Broach (Bombay). *Climate:* healthy and pleasant. *Temperature:* 46° to 112 F. *Rainfall:* 35 in.

Bulandshahr (U. P.)—Climate like Meerut.

Bijnor (U. P.) It is cool, well-drained, healthy. *Rainfall*: 44 in.

Budaon (U. P.)—Cool, moist, healthy. *Temperature*: 53° to 93°F. *Rainfall*: 34 in.

Bellary (Madras). Lies on the Northern slope of the Deccan plateau and the trend of the country is towards North-east, ranging from an elevation over 2000 (south) to 1000 (North-east).

Belgaum. (Bombay) *Climate:* The moderate heat, the early and fresh seabreeze and its altitude render it pleasant and healthy. The most agreeable climate is a tract parallel with the crest of the Western Ghat between the western forests and the treeless east. *Temperature:* 53° to 100° F. *Season* (cold and dry): October to February.

Bijapur. (Bombay) Except Badami and Muddebihal—dry and healthy. *Temperature:* 48° to 109° F. *Rainfall*: 27 in.

Champaran (Behar)—It is generally unhealthy, the *healthy towns* being Bettiah and Champaran. *Temperature*: 73°F to 97°F. *Rainfall* 54·09. *Humidity*—86%. *Diseases*: Malaria, cholera, goitre.

Chhindwara (C. P.).—*Soil*: Undulating country with hills and plateaux. At places, there is deep black loam 10 ft. thick, and at other places is thin red or yellow soil, an inch or two thick. *Elevation*: Three successive plateaux rise one above the other—1000, 2000 and 3000 ft. above sea-level. *Rainfall*: 42 in. *Climate*: cold and healthy. Temperature in winter is often below freezing point.

Chittagong (Bengal): *Soil*—It is a narrow strip of coast full of valleys and low ranges of hills. *Temperature*: Is more or less equable, 78°F to 88°·6F. *Humidity*—80 to 91% *Rainfall*—111·82 in. *Healthy towns*: Chittagong, Cox's Bazar. *Diseases*: Malaria.

Cuttack (Orissa): *Soil*: Coast line is marshy, and western portion—is hilly. *Temperature*: 69°F to 118°F. *Humidity*: 72 83 %. *Rainfall*: 59·41 in. *Diseases*: Cholera, dysentery, diarrhœa. *Healthy town*: Cuttack.

Cawnpur (U.P.) Forms a great part of the Doab or alluvial plain between the Jumna and Ganges. There is a general slope towards the south-west. The country is well-drained, hot, dry and healthy. *Rainfall*—33 in.

Chindwin, Lower (Burma). Dry and healthy. *Temperature*: 52° to 106°F. *Rainfall*: 45 in.

Cuddapah (Madras). *Soil:* The south-western portion is 1500—2250 ft. high, forming a part of the Mysore plateau—and is composed of red infertile soil, broken up by numberless small rocks. The other, the lower portion, is made up of a wide expanse of black cotton soil. *Climate*: The lowland is malarious. The upland is healthy and bracing. The Cuddapah basin is the hottest place in the whole Presidency. *Rainfall*: 28 in.

Cachar (Assam)—is divided into a plain and hilly parts. *Climate*: excessively humid ∴, oppressive. *Temperature* 65°—83° F. *Rainfall*—150 in.

Coimbatore (Madras). *Climate.* The lower hills are malarious (between Feb.—June) but elsewhere the climate is unusually dry and healthy. The *temperature* varies inversely with the altitude, being highest in the low lying valley, more moderate in the uplands on the west—coolest in the highest ranges.

Cochin (Madras) *Climate:* Damp and enervating but not unhealthy. The Chittur taluq situated within the Palghat Gap is the driest and most bracing. *Diseases*: Elephantiasis and fever along the coast. *Rainfall:* heavy. *Temperature*: 69° to 96 F.

Dacca (Bengal).—*Soil*—Mostly alluvial flats, inundated during the rains, with a small tract of rolling upland of stiff red clay, 40 ft. higher than the level of the alluvial flats. *Rainfall*: 72·03 in. *Climate*: A healthy district generally, free from malaria. *Diseases*: elephantiasis, goitre.

Damoh (C. P.):—*Soil.*—Low hills and jungles, upland valleys with occasional beds of black cotton soil. It is generally well-drained. *Elevation*: 1200 ft. *Rainfall*: 51 in. *Winds*: Violent hailstorms frequent in spring time. *Seasons*: cold in winter, temperate in summer.

Darbhanga (Behar). *Soil*:—Its south-west is upland. Warisnagar Thana is liable to inundations; the rest is low-lying, except in Madhubani Sub-division. *Rainfall*: 49·77, *Humidity*—over 80°/₀ *Temperature*: 38° to 107°F. *Climate*—generally, is dry, bracing and healthy. The cold weather (November to March) is the best; in hot weather (April and May) dry wind and dust prevail; in the rains (June to October)—hot steamy air is oppressive.

Darjeeling (Sikkim). *Soil*—is rocky in parts and alluvial in the plains (Tarai). *Elevation* : 6000 ft—7800 ft. Ridges vary from 300 to 12000 ft.—no flat valley exists at all. *Rainfall*—120 in. between June and September. *Climate* : For its excessive humidity, is not suitable for pulmonary and rheumatic affections. Adults suffer from hill diarrhoea. *Temperature* : 35° to 66°F. Snow falls between December and February. *Principal healthy places* : Darjiling, 7002 ft., Jalapahar 7500 ft., Kalimpong 3933 ft., Kurseong 4860 ft., Lebong 5970 ft., Sandakpu 11929 ft, Senchal, 8000 ft. (with excessive rainfall and depressing climate), Ghoom 7407 ft. (very rainy, misty, windy)

Dinajpur (Bengal) : *Soil* : West and South—is undulating ; the rest, alluvial plain. *Drainage* : The general line of drainage is from north towards the south. *Rainfall* : 66·06 in. *Temperature* : 49°·4 F to 78°·9 F. *Diseases* : Malaria, bowel complaints, goitre, elephantiasis.

Dehra Dun (U. P.) *Elevation* : 2,300 ft. *Soil* : rocky. The greater part of the district forms a gently sloping valley ; the other portion is a confused mass of ridges and spurs. Extremes of heat and cold are unknown in the valley. *Temperature* in the valley : 37° to 101°F. *Rainfall* : At Dehra Dun town, 89 in. ; at Rajapur, 121 in. ; at Mussouri, 96 in. ; at Chakrata, 95 in.

Dharwar. (Bombay) The climate is about the healthiest in the Bombay Presidency. In December and January, dews are heavy and general. Strong winds blow in November and December. *Temperature* : 80° to 98° F. *Rainfall* : 33 in.

Etah (U. P.) Dry, healthy ; dust-storms in hot season and intense cold in winter. *Rainfall* : 29 in.

Fatehpur (U.P.) Forms a part of the Doab or alluvial plain between the Ganges and Jumna. The climate is hot and damp but not unhealthy. West wind in summer is not so trying. *Rainfall* : 34 in.

Furrukhabad (U. P.)—One of the healthiest districts in the Doab. The upland is dry, the trans-Gangetic parganas are unhealthy. *Rainfall* : 33 in. *Temperature*—58° to 95°F.

Gaya (Behar). *Temperature*: 64°F to 105°F. *Rains*: 42·94. *Humidity*: 51% average, but 84 to 87% in July and August. *Wind*: Hot, dry, dusty. *Diseases* :, Plague, malaria, typhoid and cholera occasionally; dysentery, diarrhoea, cataract, stone, filarial disease—are common. *Principal places*: Nawada, Tikari, Sitamarhi, Jahanabad.

Ganjam (Madras) *Soil:* mountanous and rocky and interspersed with valleys and fertile plains. *Climate:* cool and healthy but the town Ganjam is unhealthy. This district is one of the few in the presidency which enjoys a really cold season. *Rainfall*—55 in.

Godaveri (Madras). The north-east is occupied by Eastern Ghats; the east is a delta and an upland forms the third division of this district. *Climate*: Healthy on the whole except during rains, when it is very humid.

Hyderabad (Sind). *Soil*: Alluvial plain with numerous swamps. In the east, sandy and barren; in the south, are extensive salt plains. *Temperature*: 22° to 104°F. *Rainfall*: 5·7 in. *Climate*—healthy. *Diseases*: Malaria.

Hazaribagh: *Soil*—partly rock and partly ravine. It is made up of two plateaux, 2000 and 1300 ft respectively, separated by the Damudar valley between. *Rainfall*: 53 in. *Temperature*: 51° to 99° F. *Humidity*: 36% to 41%. *Principal places*: Hazaribagh town (2000 ft) located amidst a group of conical hills. Pareshnath Hill—(4480 ft)—is in part malarious.

Hoshangabad (C. P.). *Soil*: Plains consist of alluvial stiff brown clay with 'Kankar' abounding. The edges are hilly—2000 to 4000 ft. above sealevel. *Rainfall*: 50 in. *Winds*: Thunderstorms and hail are frequent; dust storms are absent. *Panchmari Hills*—form the summer head quarters.

Howrah (Bengal). *Soil.*—Flat alluvial plain, the drainage of the district being towards the south and south-east. A large portion of lt is lowlying, studded with marshes and filled up river channel. *Rainfall*: 59·47 in. *Diseases*: Malaria and bowel complaints.

Hughly (Bengal) : *Soil* : Alluvial plain throughout, except the thana Goghat, which may be called an upland. West of the Dwarakeswar river, the ground is undulating, the soll rocky and the slope marked. *Rainfall* : 58·03 inches. *Diseases* : Malaria.

Hardoi (U. P.) : It is a level plain. *Climate* : cool, healthy and dry. *Temperature* : 50° to 105° F. *Rainfall* : 32 in.

Hamirpur (U.P.) Lies chiefly in the great plain of Bundelkhand between the Jumna and the outer scarps of the Vindhyan plateau. *Climate* : dry and hot. *Rainfall* : 36 in.

Hazara (N. W. F.). *Climate :* is healthy, though hot. *Rainfall :* 30 to 50 in.

Jaipur State (Rajputana) : *Soil* : Centre—is an elevated tableland, 1400 to 1600 ft. high above the sea. North—is a sandy desert ; South—is a fertile alluvial plain. In the S. E. are ranges of low hills, intersected by ravines. *Rainfall* : 23 in. *Temperature* at the chief city is 77°F. *Climate* : Dry and healthy.

Jaisalmir State (Rajputana). *Soil*—sandy waste, being part of the great Indian desert. Occasionally, there are low rocky hills ; but generally, the aspect is that of an interminable sea of sand hills some 50 ft. high. *Rainfall* : 7 in. *Climate*—dry and healthy.

Jodhpur or Marwar State (Rajputana) : *Soil* : Mainly sterile and sandy, covered with sand-hills (at times 300 to 400 ft high). N. and N. W.—desert, where water occurs 200 to 300 ft. below soil surface. There are some salt lakes. *Temperature :* 28° to 121°F. *Rainfall :* 13 in.

Jabbalpur (C. P.) *Soil* :—Mostly open plain, but in parts, broken and hilly. Alluvial flat or stiff red or brown clay, with 'Kankar' form the soil. Jabbalpur city is 1306 ft above sealevel. *Rainfall* 59 inches. *Temperature* : 32° to 106° F. *Climate* is pleasant and salubrious.

Jalpaiguri (Bengal). *Soil* : alluvial. *Temperature* 62° to 83° F. *Diseases* : Goitre, malaria, kala azar. Very unhealthy specially in the eastern parts.

Jessore (Bengal). *Soil* : Alluvial plain intersected by many rivers. *Rainfall* : 66·70 in. *Climate* : most unhealthy—epidemics of cholera and malaria being frequent.

Jhansi (U. P.). *Soil* : Black coloured. It is a high plateau, about 2000 ft. high on the south, the north being more level. The slope is from S. W. to N. E. The highest ground (south), which extends to the two outer scarps of the Vindhyan plateau, breaks up into a confused mass of hills, some of which are 2,000 ft. Next is an undulating plain of black soil ; then appear low red hills of gneiss. *Climate :* hot, very dry and not unhealthy (except in autumn). In the south the *temperature* is lower than in the north. *Rainfall :* 31 in. Hailstorms are common in winter.

Jalaun (U.P.). *Climate :* hot, dry, not unhealthy. *Temperature :* 65° to 96°. 5F. *Rainfall* : 32 in.

Karachi (Sind). *Soil* : Mostly flat alluvial plain—ferruginous red sand and loam, except in the west, where spurs from the Beluchistan hills diversify the monotony of the arid surface. *Temperature* : Annual average 79°F. *Rainfall :* 9 in. *Climate*—is fine and superior to that of the rest of Sind. Nice sea-breeze is present. *Healthy towns* : Karachi, Manora. *Disease :* Plague. [At *Pir Mangho*, there are hot springs amidst rocky hills. Hot sulphur springs also exist at *Lakhi* in the Kotri Taluq].

Kashmir : The central part, the valley, is surrounded on all sides by massive mountains 50 or 60 miles in width, rising to 18,000 ft. or more above sealevel. It is diversified in its natural aspects beyond description. The valley is 6000 ft. above sealevel. *Soil* of the valley—alluvial ; what was once a lake has dried up. A feature of the country are the lagoons or swamps ; also, *thermal springs* exist at Achabal, Arpal, Kokarnag, Maliknag (sulphurous), Vernag. *Temperature* (at Srinagar) 33·1°F to 74·6F. Earthquakes and floods are rather common in the Valley. *Chief towns :* Srinagar (insanitary)., Gulmarg (healthy), Sonamarg (healthy). *Rainfall :* 30 in.

Khasi end Jaintia Hllls. (Assam) *Elevation*—A wide plateau 4 000 ft.—6000 ft. *Climate :* cool, pleasant and healthy. *Tempera-*

ture seldom exceeds 80° F and in winter ice forms. Malaria occurs in the low plains. *Chief town:* Shillong.

Kathiawar. (Bombay) *Climate:* pleasant and healthy; unhealty during September to November; but in January to March occur thick fog and heavy dews. *Rainfall*: 30 in.

Kolhapur (Bombay). *Elevation:* 1800 ft. *Climate:* temperate on the whole. *Rainfall*: 40 in.

Khulna (Bengal). *Soil*—alluvlal plain, a region of morasses and swampy islands. *Rainfall*: 65·,97. *Climate*—not healthy but neither conspicuously unhealthy. Malaria and cholera are the prevailing diseases.

Kistna (Madras). *Soil.* Strongly upland in the west and alluvial delta on the east. *Climate*: Very hot but healthy. *Temperature*: 58° to 117°F. *Rainfall:* 33 in. *Climate*: exceedingly dry throughout and correspondingly healthy. The western portions are considerably cooler. *Rainfall:* 30 in.

Lakhimpore (Assam). Cool, pleasant and healthy. *Rainfall* —167 in. *Temperature:* not oppressive even in June and July.

Larkana (Sind). *Soil:* Alluvial, except in the west, where there are hills rising to 6200 ft. There is a sulphurous *spring* at Dhara Tirth (temperature from 102° to 124°F), which is good for skin diseases and rheumatism. *Temperature*: 43° to 115°F. *Rainfall:* 2 to 9 in. *Loo* is very trying in April; so is the cold wind from N and E in winter.

Loralai (Baluchistan). *Climate:* dry, healthy. Summer is cool and pleasant but winter is intensely cold. *Rainfall*: 7 in.

Lucknow (U. P.). *Soil*: Gangetic alluvium. *Temperature* (maximum): 110° F. Hot westernly winds and dust-storm are frequent from March to May.

Lushai Hills (Assam). *Elevation:* 3000 (west)—4000 (east) and 8000 ft. here and there. Valley is malarious; on the higher ridges—cool even in the hottest weather; storms frequent during rains. *Rainfall*—80 in.

Mandla (C. P.). *Soil* : Wild, hilly country, culminating in Amarkantak plateau. *Elevation*—1500 to 3400 ft. *Rainfall* : 52 in. *Winds* : Hail storms frequent in winter and thunder storms in summer. *Diseases* : malaria.

Mazafarpur : *Soil*—one vast alluvial plain, the general slope being from N. to S and S. E. *Rainfall* : 45·61 in. *Climate*—dry, bracing, healthy. *Diseases* : Fever, plague, cholera, goitre, dysentery, diarrhoea, skin diseases.

Mirzapur. (U. P.). *Soil*—North part is alluvial, being part of Gangetic plain, south part is plain, formed by outlying hills of the Vindhya range—stiff, shallow, red clay. *Rainfall* : 41 in. *Temperature*—does not fluctuate much. *Climate*—unhealthy at commencement of hot season and at end of the rains.

Midnapur (Bengal). *Soil* : East is purely alluvial, west is undulating, with long rolling waves of laterite rock,—the surface being alternate ridges and depressions. The eastern part is waterlogged. *Rainfall* : 59·45 in. *Seasons* : the east is hot, humid ; the west is fiercely dry and hot. *Diseases* : Malaria, elephantiasis, bowel complaints.

Monghyr (Behar). *Soil* : Hilly to the south and lowlying to the north of the Ganges. *Temperature*—changes are great and sudden. *Healthiest season* : March, April, May. *Rainfall* : 49·01 in. *Diseases :* Bronchitis, pneumonia, asthma, calculus, elephantiasis, goitre (along the Burh Gandak river), ophthalmia. *Healthy places :* Begusarai, Jamalpur, Jhajha, Jamooi, Kiul, Monghyr, Simultala (1000 ft. above sealevel).

Murshidabad (Bengal) : *Soil* · (1) West of the Bhagirathi, the soil is high and undulating, of laterite clay and nodular limestone, reddish in colour, mixed with lime and oxide of iron. (2) East of the Bhagirathi, is ordinary alluvium. *Drainage*—is from north-west to south-east. *Rainfall :* 55·23 in. *Humidity* : 79 to 84% *Diseases :* Malaria.

Meerut (U. P.) One of the healthiest districts. From November to March, the weather is cool and invigorating, hoarfrost being frequently found in January. *Temperature* : 57° to 91°F. *Rainfall* : 29 in.

Muttra (U. P.) *Climate* : Hot, dry. *Temperature* : 60° to 93°F. In winter ice forms ; in summer, hot winds blow with great force. *Rainfall* : 26 in.

Mandalay (Burma). *Climate* : Dry, healthy ; strong winds prevail from April to October. *Temperature* : 55 to 107°F. *Rainfall* : scanty.

Meiktila (Burma). *Climate :* Dry, healthy. *Temperature :* 62° to 101°F. *Rainfall :* 25 in.

Myingyan (Burma). *Climate :* Healthy and exceptionally dry. A strong high dry south-westernly wind blows throughout the rains. *Rainfall* : scanty.

Mergui (Burma)—*Climate* : Mild, moist, healthy. *Rainfall* : 163 in.

Madura (Madras) *Climate :* hot, dry and variable. No real cold season exists on the plains. The climate of the upper Palnis is probably one of the finest in India. *Rainfall* : 30 in.

Malabar (Madras) *Climate :* excessively damp but healthy ; seabreeze blows even during the hottest weather. *Temperature* : 70 to 90 F. *Rainfall* 116 in.

Nadiya (Bengal). *Soil :* Alluvial plain. The whole district is a network of moribund rivers. *Rainfall :* 57 in. *Diseases :* Epidemics of Malaria (Kala Azar ?).

Nasik (Bombay). *Soil* : Rocky tableland, hills intersected by ravines *Elevation* : 1300 to 2000 ft. *Rainfall* : 29 in. *Temperature* : 50° to 105°F. *Sanitarium* : Nasik town—which has the best climate in the Bombay Presidency. *Season :* June—Nov.

Nepal State : *Soil*—is extremely diversified in nature ; from the Terai or low-lying lands in the south to Himalayan peaks, all kinds of soil occur. It consists of four zones running successively upwards from east to west : (*a*) The Tarai—at the foot of the hills ; (*b*) the sandstone (range 2500 ft. above sea)—a continuation of the Siwaliks ; (*c*) hill region—5000 to 10000 ft ; (*d*) mountain region—

above 10000 ft. high. The Tarai and the region up to 4000 ft. are malarious. Above 4000 ft., the climate is excellent, though the moisture (June—October) is excessive. *Diseases* : Malaria, small pox, phthisis. The Valley of Nepal proper—is a plateau, 4700 ft. above sea and surrounded on all sides by mountains rising to 7000 to 9000 ft. *Rainfall :* 56½ in. *Temperature* : 51° to 77°F.

Nilgiris (Madras)—Consists of (1) A higher plateau (mostly 6500 ft. above sea) on East. (2) A lower plateau (2000 to 3000 ft. high) on the West,—with the Western Ghats as a dividing ridge. *Soil.*—Rolling, grassy downs with no level ground. *Rainfall.*—67 in. *Unsuited to* : cases of P. P., heart, dysentery and sluggish liver. *Sanitaria* : Ootacamund, Coonoor, Wellington and Kotagiri. (1) *Ootacamund town*—(7500 ft.) is the chief sanitarium in South India ; *rainfall*—49 in. (2) *Wellington town* (6100 ft.) *Rainfall*—47 in. *Temperature*—62·3° F. (3) *Coonoor—Rainfall*—63 in. Temperature : 38 to 75 F. (4) *Kotagiri*—Rainfall—62 in., is warmer than Ooty and exposed to S. W. monsoon. These climates are not so invigorating as those of Europe and are bad for dysentery and sluggishness of the liver.

Naini Tal (U. P.). About ⅙th of this district lies in the outer ranges of the Himalayas ; it is a part of the Himalayan ranges, except a small patch of level alluvial country in the south. *Elevation*; 6000 ft. upwards. Then it rises abruptly from the plains. Below is a damp strip of land in which the mountain torrents sink ; below it, is the damp tarai region. The hills alone are cool, bracing healthy. *Temperature* : 26° to 85° F. *Rainfall* including snow : 95 in. *The Town*, Naini Tal, is 6400 ft. above sea level. *Season :* October to December and April to June (dry heat.)

North Arcot (Madras). *Climate* : Dry and healthy. The low country is hot, while the elevated tract on the west shares the cooler temperatures of the adjoining Mysore plateau. *Rainfall :* 37 in.

Nellore (Madras). It forms a part of the plains of the Carnatic and rises very gradually till it reaches the foot of the Eastern Ghats. *Climate* : Dry, healthy, equable. Heat is excessive owing to scorching dry wind for three months in the year. The coast is cooler than the inland, on account of seabreeze. *Temperature*: 77° to 112°F. *Rainfall*: between 11 and 42 in.

Naga Hills (Assam)—Narrow strip of hilly country. *Climate*: cool. Higher hills are healthy. During rains malaria prevails. *Rainfall*—80 to 100. *Elevation*: 10,000 ft.

N. Canara. (Bombay) Coast—moist, healthy; upland forest tract is malarious. Severe thunderstorms during rains.

Noakhali (Bengal): *Soil*: (1) North-east part is elevated and undulating. (2) Centre—a vast alluvial plain. (3) South—has islands There are numerous marshes. *Rainfall*: 112·22 in. *Diseases*: No epidemics of fevers are prevalent. Round worms and ringworms are exceedingly prevalent.

Orissa Tributary States: *Soil*: It forms a succession of hill-ranges rolling backwards towards Central India. *Temperature*: 33° to 112° F. *Diseases*: Malaria, kala azar. *Chief places*: Anantapur, Baripada, Baud, Bhowanipatna, Bolangir, Deoghar, Dhenkanal, Keonjhar.

Pudukkotai (Madras) *Diseases*: guinea worm very common. *Climate*: Cool and healthy. *Rainfall*: 35 in.

Patialla State (Punjab). *Soil*—Mostly alluvial, except a part which is hilly. *Rainfall*—40 in.

Poona (Bombay). *Soil*—Plateau free from alluvial deposits. This undulating district is cut up by spurs of Western Ghats range; in part it is most rugged, cut up by valleys and ravines. *Elevation*:—1800 ft. *Climate*—Invigorating and dry, well suited to Europeans. *Air*—is light. Heat—oppressive. Cold—bracing. Temperature—48°—107° F. *Rainfall* at Poona city—32 in. At other places—185 in. *Sanitarium*—Poona city (1850 ft.)

Peshawar (N. W. F.). *Season*: February to April, when the air is cold and bracing. December and January are intensely cold. May to July—thunderstorms and dust-haze are common. *Rainfall*: 17½ in. Atmosphere becomes humid after rains. *Diseases*: Malaria, lung complaints.

Partabgarh (U.P.) *Soil :* Richly wooded, alluvial plain. *Climate :* dry and healthy. *Temperature :* 60° to 92° F. *Rainfall :* 38 in.

Palamau. (Chhotanagpur) *Soil* : Essentially hilly, broken up by jungles and streams with little lableland. *Elevation :* 2000 to 3000 ft. *Humidity :* 52%. *Rainfall* : 48·16 in. *Temperature* : 59 to 107° F. The heat is dry. October to March – is bracing.

Patna (Behar). *Soil :* Alluvial, being hilly in south-east and intersected by rivers. Southern part is under water during the rains. Drainage is from south-west to north-east. *Temperature* : 60° to 101° F. *Humidity :* 86%. *Rainfall :* 45·26 in. *Diseases :* Malaria, plague, cholern, typhoid, dysentery, capillary bronchitis.

Purnea (Bengal). *Soil :* Alluvial flat. In the south-west are some marshes. *Rainfall :* 64·36 in. *Diseases :* Very unhealthy owing to moisture, malaria and cholera.

Puri (Orissa . *Soil :* Alluvial. *Rainfall :* 55·66 in. *Temperature :* 77° to 89° F.—practically equable owing to breeze all the year round. *Humidity* being great (75 to 86%), long residence has enervating influence. *Diseases* : cholera, fllariasis. *Suitable for* : phthisis or convalescents from fevers and bowel complaints, asthma. *Principal Town :* Puri, Bhubaneswar, Cuttack.

Quetta-Pishin (Baluchistan). *Climate* : dry ; but dust-storms are common in spring and summer. *Temperature* : 0° to 78° F. *Rainfall :* 10½ in.

Rai Bareli (U.P.) *Soil* : undulating plain of Gangetic alluvium. *Climate* : healthy and comparatively equable. *Rainfall* : 37 in.

Ratnagiri (Bombay) *Climate* :—moist, relaxing but healthy. *Temperature* : 61° to 93° F. Strong gusty wind blows in rainy season.

Rajshahey (Bengal). *Soil* : mainly aluvial ; but in the north and west) the Barendra tract) the soil is stiff, reddish clay, slightly undulating and elevated. The eastern part is water logged, the Barendra tract is drier than the alluvial plain. *Rainfall* : 55½ in. *Temperature* : 42 to 108° F. *Climate* is damp.

Ranchi (Behar). *Soil* : undulating tableland, bare and rocky where level ; and where undulating, clothed with scrub jungle. It consists of two plateaux—1000 and 2000 ft respectively. Highest hill is 3615 ft. and Ranchi town is 2100 ft. above sealand. *Rainfall :* 52 in. *Humidity :* 43%. *Temperature :* 51° to 100° F. *Diseases* : The more jungly tracts are very malarious ; others are healthy.

Rangpur (Bengal). *Soil :* Alluvial plain, except for a small tract along the west, which is a high land of stiff red clay. *Rainfall* : 78·8 in. *Temperature :* 61° to 89°.8 F.—somewhat equable and mild. *Diseases :* cholera, dysentery, rheumatism, asthma, goitre, ainhum.

Singbhoom (Sonthal Pergs). *Soil* : Hilly upland. *Rainfall* : 58·32 in. *Temperature* : 67° to 105° F. *Climate* : Air is bracing and peculiarly dry, except in Dhalbhoom, which is humid. *Diseases*—Malaria is endemic in Manoharpur thana, Kohlan, N. & W. of Chakradharpur and south of Ghatsila thana. *Healthy stations* ; Chaibassa, Chakradharpur, Dhalbhoom, Ghatsila, Kalimati.

Sonthal Parganas (Bengal) : *Soil*—mostly upland tract, with a hilly backbone from north to south. The general slope is from N. W. to S. E. The whole tract is easily drained and therefore dry. *Rainfall* : 53 in. *Temperature* : 51° to 120° F. *Humidity* : 49 to 52 % *Healthy towns* : Baidyanath, Deoghar, Dumka, Naya Dumka, Jamtara, Adra, Dhalbhum, Gobindapur, Jhalda, Karmatar, Madhupur, Mahespur, Raghunathpur, Shahebgunj.

Sind Frontier District (Head Quarters,—Jacobabad). *Soil*—Mostly alluvial deserts, but partly hilly. There is some sand and a good deal of alkali land. *Rainfall*—3 in. *Temperature* : 88° to 126°F—the hottest in India. *Humidity*—over 70%.

Sukkur (Sind). *Soil*—alluvial plain, broken here and there by low limestone hills. There are occasional patches of salt land also ridges of sand hills. *Temperature*—61°—120° F. *Rainfall*—4·4 in. *Climate* ; hot, dry, free from air currents ; hence, very trying.

Sitapur (U. P.) *Soil* : undulating plain of Gangetic alluvium ; remainder is a raised upland. *Climate* : cool, healthy. *Temperature* : 45° to 110° F. Frost is common in winter. *Rainfall* 38 in.

Sultanpur (U.P.) *Soil* : alluvial. *Climate* : Mild and healthy. *Temperature* : 65° to 100° F. *Rainfall* : 40 in.

Surat (Bombay).—*Climate :* On the coast (upto 8 miles) there is seabreeze and therefore equable. *Temperature* inland is—44° to 109° F. *Rainfall :* 35 in.

Sholapur (Bombay). *Climate* : Healthy and agreeable except from March to May. *Temperature* : 52° to 108° F. *Rainfall* : 26 in. *Climate* : moist and relaxing but healthy. *Temperature :* 61° to 93° F. Strong gusty wind blows in the rainy season.

Sagaing (Burma) : Cool, healthy. *Temperature* : 60° to 102° *Rainfall :* 5 in.

Shan States (Burma).—*Climate :* Temperate and healthy. *Temperature* : 65° to 96°F. In the uplands, frosts occur.

Sylhet (Assam). Extremely humid.—There is no hot season—the air is always cool. Fairly healthy, except in Terai—where malaria is endemic. *Rainfall*—in the Northern parts 250 in. ; in the Southern parts, 100 in. *Soil* :—rich alluvial, being the lower valley of a river.

Shibsagar (Assam) : *Climate :* Damp but cool and healthy. *Rainfall*—95 in. *Temperature :* 60° to 84° F.

Salem (Madras). Made up of five divisions—the elevated portion (3000 ft.) being situated on the Mysore table-land. The other two are 13000 ft. The elevated portion is as pleasant as the Mysore tableland ; while, in the lower levels, the heat is oppressive. *Rainfall* : 32 in.

S. Canara (Madras) *Climate :* Relaxing, debilitating, very humid.

Sambalpur (C. P.)—is an undulating upland, broken up by rugged ranges of hills. *Temperature* : 49° to 113°F. *Rainfall :* 58·49 in. The heat is oppressive but dry. *Diseases* : Malaria, rheumatism, dysentery, respiratory diseases.

Saran (Behar) : *Soil* : Alluvial plain well drained by rivers. *Temperature* : 50° to 100° F. *Rainfall* : 45·05 in. *Diseases* : Malaria, plague, cholera, goitre.

Saugor (C. P.). *Soil*: Partly flat open black-cotton soil and partly undulating, with isolated hills. *Elevation*: 1000 ft. above Nerbudda valley. *Rainfall*: 47 in. *Temperature*: 41° to 112°F. *Diseases*: None. Healthy all the year round.

Seoni (C. P.). *Soil*: Hills and plateau chiefly, with occasional patches of black-cotton soil. *Elevation*: 2000 ft. *Rainfall*: 52 in. *Climate*: cool, pleasant and healthy all the year round, excessive heat being rare even in summer.

Shahabad. *Soil*: Portion is plain (clay and sand) and portion is rocky. *Rainfall*: 43 in. *Diseases* (occasionally): Plague, fever, cholera, dysentery, diarrhoea. *Healthy places*: Arrah, Bhabua, Buxar, Dehri, Dumraou, Rhotasgarh (1490 ft.), Sasaram.

Shillong (Assam.) *Soil*: Rocky, stiff clay, often indurated with particles of iron. The hills rise in succession upto 6000 ft. *Rainfall:* at Cherrapunji—458 in. and at Shillong—82 in. Temperature never rises over 80° F in the hottest weather and in winter water freezes. It is always subject to earthquakes.

Tipperah (Bengal): *Soil*: Plain slope from north to the south. *Seasons*:—unlike other places in Bengal, the rainy season is the healthiest and the cold weather the unhealthiest. *Diseases*: Malaria, cholera, dysentery.

Twenty-four Parganas (Bengal). *Soil*: The northern tract is alluvial land of sluggish or stagnant rivers. The south is the Sundarban area—swampy morasses, a network of islands and rivers and tidal channels. *Healthy towns*: Calcutta, Barrackpur. *Diseases*: cholera, malaria, kala azar, typhoid fever, dysentery.

Thar and Parkar (Sind). *Soil*—The first part is a level plain of stiff clay; the second part is a desert with sand hills; the third part consists of hill ranges of hard rock. There are large expanses of salt waste here and there. *Temperature*—Mean at Amarkot town 76° F. *Rainfall*—at Amarkot to 6-9 ins.

Tavoy (Burma). *Climate*: pleasant; heat of summer is moderated by sea breezes. Fogs in December and January, Squalls of wind and thunderstorm in April and May. *Rainfall*: 228 in.

Thayetmyo (Burma). *Climate* : Dry, healthy. *Temperature* : 42° to 105°F. *Rainfall* : 31 in.

Travancore (Madras). *Climate:* along the coast is damp and equable ; at foot of hills—on the High Range—temperate. *Temperature* : 70°- to 90° F.

Tanjore (Madras). *Climate* : Generally healthy ; hot and relaxing in the delta.

Trichinopoly (Madras). *Climate :* Dry and healthy and very hot. *Rainfall* : 34 in.

Tinnevelly (Madras). *Rainfall* is light and *Temperature* is equable.

Unao (U.P.). *Soil :* alluvial. The district is a gently undulating upland, in which ridges of high and rather sandy land alternate with depressions of stiffer soil. *Temperature* : 46° to 103° F. *Rainfall* : 35 in. *Climate* : healthy.

Vizagapatam (Madras). *Soil*—Mostly hilly and picturesque in the North ; the South is a cultivated plain—the dividing line being the Eastern Ghats (2000—3000 ft). The Northern Ghat is a succession of 3 plateaux. *Temperature*—mean at Vizag town (Waltair) is 82° F. Climate is pleasant in winter but moist and relaxing at other times. Moist and relaxing along the coast ; hottest and drier inland and wettest and coldest in the hills. *Rainfall* at coast regions : 38 in. ; on Eastern Ghats, 51 in. *Diseases*—malaria, beri-beri, and elephantiasis.

Zhob (Baluchistan). *Climate* : dry and bracing, in the Upper Zhob ; damp and enervating in the Lower Zhob. *Rainfall* : 10 in. Snow falls in winter.

Remarks.—In the above gazetteer, we have included only the healthy districts (except in the case of Bengal).

The **tropical zone** comprises a belt extending about $23\frac{1}{2}°$ of latitude on either side of the equator. The following places possess tropical climate :—(1) The Mediterranean Basin—specially, Algeria, Malta, Syrian coast, Cyprus, Egypt (Alexandria, Cairo, Luxor, Assouan). (2) Africa. (3) Red Sea coasts. (4) Madagascar and

Mauritius Is. (5) Palestines. (6) Persia. (7) India and Ceylon (8) Burma, Siam and Cochin China. (9) Southern China. (10) Formosa. (11) Malay Archipelago. (12) Northern Australia. (13) Islands of the Pacific.

India is roughly divided into an upper continental or northern half and a lower peninsular or southern half. The CONTINENTAL HALF is subtropical, being above the Tropic of Cancer and is climatically divisible into three successive zones from north-west to south east, viz., (*a*) *The Frontier zone* (including N. W. F. provinces, the Punjab, Sind and Rajputana). Here there is practically no rainfall ; the hot weather lasts nearly seven months and is intolerable ; it is very dry and the daily range of temperature in summer is small. The cold weather lasts five months and, in some places, is bitter ; in others, delightful. (*b*) *The United Provinces* (from Oudh to Behar)—possess the finest climate in India, specially the Rohilkhand portion of it. It is dry, very hot in summer and delightfully cool and bracing in winter ; while the rains are neither too much, nor too little. (*c*) *Bengal and Assam.*—The heat is great, the cold weather is short, the rains are excessive—specially in Assam.

In THE PENINSULA, where the climate throughout the year is more or less equable, on account of the sea, the rainy season occurs twice, the cold is short. Its north western part (*e.g.*, Kathiawar, Surat &c) is dry with scanty rainfull (as in the case of the continental frontier zone) and its north eastern portion (Orissa) is moist, with heavy rainfall.

(E.) HILL SANITARIA IN INDIA.

[There are five principal mountain-ranges in India : (1) *The Himalayas*—which rise by successive ranges to a mean height of 20,000 ft. ; (2) the *Vindhya Mts.* ; (3) the *Arvalli Mt.* ; the *Eastern* and (5) the *Western Ghats*. The southern slopes of the Himalayas and the west coast of the peninsula receive the most rains. Very little rain falls to the west of the Arvalli hills. Places at the foot of high mountains, called *the Terai*, are intensely malarious and humid and no hill above 6000 ft. is free from malaria. Even in some of the high hill sanitaria, malaria occurs after the rains. As a rule, in all the very great elevations, one is liable to suffer from acute pneumonia, bronchitis or rheumatism and in some hill stations, from hill diarrhoœa.]

Abbottabad (Hazara Dt., Punjab). *Elevation* : 4,120 ft. *Soil*—alluvial clay, situated on a valley surrounded by mountains. *Temperature* : 27°·2 F (January) to 98° F (June) ; cool breeze blows in summer. *Rainfall* : 20 in. *Season* : November to March. Though less cool, it is far healthier than most hill sanitaria. *Diseases* : Malaria (after October) ; pneumonia, pleurisy, bronchitis, rheumatism (December—January). *Diseases benefitted* : Heart cases.

Abu (Rajputana). *Elevation* : 4,000 ft. *Temperature* : 58° to 96° F. *Humidity* : 29 to 87%. *Rainfall* : 63 in. *Season* : January to June ; the cold is dry. *Drainage & watersupply*—good. *Diseases* : Malaria (almost all the year round, specially in Sept. and October). *Cases benefitted* : Hepatic disorders, early cases of phthisis, general breakdown of health.

Almora (Kumaon Dt.). Healthiest place in the Kumaon district. *Elevation* : 5,400 ft. *Temperatures* : 36° to 88° F. *Rainfall* : 38 in. There is little vegetation and therefore no shade. *Soil*—rocky. *Drainage* : good. *Season* : September and October. *Diseases* : Malaria, dysentery (during rains), acute chest diseases, rheumatism &c. (in winter). *Cases benefitted* : Malaria. *Cases unsuited* during dry weather : phthisis.

Bhim Tal (U.P.). 5000 ft. Unlike Naini Tal, it is free from malaria but is not so bracing.

Bukloh (Punjab) *Elevation :* 4,300 ft. Not particularly healthy. *Diseases* : Rheumatism, acute chest affections, ophthalmia &c.

Chakrata (Punjab). *Elevation* : 7000 ft. *Temperature* : 42° to 67° F. *Humidity* : 63 to 66%. *Ra?nfall* : 60 in. *Season* : Oct. to June. The cold is dry and bracing. The cold in January and February is very trying. *Cases benefitted* : Malaria, general ill health (anæmia, debility &c.). *Cases unsuited* : Gout, rheumatism, heart disease.

Chaubattia·—See Ranikhet.

Cherat (Peshawar). *Elevation* : 4,300 ft. *Temperature* : maximum—96° F. *Rainfall* : 13 in. *Season* : September to May. The air then is cool, dry and bracing. Lung and liver cases should go before the onset of cold weather. *Diseases* : none, except pneumonia and rheumatism in cold weather. *Cases benefitted* : General ill health (anæmia, debility, exhaustion, nervous breakdown &c.)

Chikalda (Berar). *Elevation* : 3,600 ft. *Temperature* : 46° F. to 99° F. *Humidity* : 35 to 52%. *Rainfall* : 66 in. (=92% humidity, in July and August). *Season* : October to March.

Cherrapunji (Assam). *Elevation* : 4,400 ft. *Rainfall* (May to September) 415 in. *Humidity*—very great. *Diseases* : None.

Coonoor,—See pp. 379.

Dagshai (Punjab). *Elevation* : 6,100 ft. *Temperature* : 20° F to 88° F. It is devoid of vegetation and exposed to inclemencies of the weather. *Climate* : similar to that of Simla.

Dalhousie (Punjab). *Elevation* : The station is built on three peaks 6,000 to 7,700 ft. *Drainage* : good. *Soil* : porous. *Temperature* : (highest) to 85° F. *Rainfall* : 65 in. *Season* : October to May, bright, clear and bracing. The cold is not severe. *Cases suitable* : General ill health ; cachexias.

Darjiling (Sikkim). *Elevation*: 7,400 ft. *Rainfall* : over 144 in. (June to August). May and June are misty. *Temperature* : 25° to 72° F. *Season* : October to February—when it is sunny and delightful. Snow falls in winter but the cold is not severe. The *climate* is equable ; and wind and storm are rare. *Humidity* : 75 to 94°/ₒ. *Diseases* : Malaria, hill diarrhœa (in the rains). *Cases unsuitable* : those with organic diseases of brain, heart, kidneys, liver &c. *Cases suitable* : Weak children (see p. 372), hepatic disorders, malaria, general ill-health.

Dharmasala (Punjab). *Elevation* : Mc Leodganj—6,150 ft. ; Kotwali Bazar—5,900 ft. *Soil* : Red clay with sand-stone and calcareous rock. *Rainfall* : 157 in. *Temperature* : 57° to 90° F. *Humidity* : 90% during the rains. During rains the place is damp, foggy and unhealthy. *Season* : November to February. *Cases benefitted* : None special.

Gullies—are little-known stations on the road between Murree and Abbottabad, which are healthy, quieter and less overcrowded.

Gulmerg (Kashmir). *Elevation* : 8,500 ft. *Rainfall* : 90 in. *Season* : June to September. The *Climate* is bracing and very healthy.

Jalapahar *Elevation* ; 7000 to 8000 ft.—See Darjeeling.

Kailang—See Lahaul.

Kangra (Punjab). *Elevation :* 2,350 ft. *Rainfall* : 150 in. *Temperature* : rises to 85° F. *Diseases* : Malaria, bowel complaints (all the year round), leprosy, scurvy, goitre, rheumatism (in winter). Near it is Jwalamukhi and a hot *spring* containing iodine.

Kasauli (Punjab). *Elevation* : 6,400 ft. *Temperature* : 45° to 69° F. *Rainfall* : 72 in. *Drainage*—good. *Season :* October to January. The rainy season is not quite disagreeable. *Cases suitable :* weak children, malaria. *Cases unsuited* : Heart and kidney cases ; convalescents from malaria.

Kashmir (See p. 375). The climate is truly Alpine. *Season* : September to December and March to June. Snow falls in December and January ; July to August are malarious. *Diseases* : Malaria, cholera and bowel complaints ; pneumonia, rheumatism. *Cases benefitted* : Malaria, torpid liver, early phthisis, dyspepsia, nervous breakdown. There are hot *springs* near Baramula (sulphuretted) and Panipur. As most of Kashmir is inaccessible, only those of robust constitution, who can camp out and boat, can really enjoy Kashmir.

Khandala (Poona). *Elevatian* : 2300 ft. Its *advantages* are : (*a*) It becomes quickly dry after the rains ; (*b*) the change from Bombay to here does not involve much reduction of temperature ; and (*c*) sea breeze is plentiful, specially in April and May. Mean average *temperature*—80°F. *Cases benefitted* : General ill health. *Season* : October to June.

Kodaikanal (Madura, Madras). *Elevation* : 7300 ft. *Rainfall* : 60 in. *Temperature* : 42° to 76°F. *Soil*—gravelly. *Drainage*—good. *Season* : January to August. January to March is dry and cool, with occasional slight frosts. May is showery, with thunderstorms. September to December is rainy. But the *soil* is extremely porous.

Kotagiri (Madras). *Elevation* : 6,500 ft. *Mean temperature* 60°F. *Mean humidity* : 73% *Rainfall* : 50 in. See p. 379.

Kulu (Punjab). *It includes* the districts of Lahaul, Spiti and Kulu (of which the last = 2000 sq. miles in area), the chief town is Sultanpur (4,086 ft.) and the villages Nagar, Manali and Rahla occupy altitudes 6000 to 8000 ft. *Season* : October to December (in the higher altitudes)—the lower altitudes being malarious. There is a hot *spring* at Manikaran.

Kurseong (4000 ft.)—See Darjiling.

Ladakh (Kashmir). *Elevation* of this district : 9000 to 14000 ft. Chief town : Leh—11,500 ft. *Temperature* : 4° to 90°F. *Rainfall* : 2·7 in. *Climate*—very dry and healthy, invigorating. "To be suffering from heat on one side of one's body, while painfully cold on the other, is not uncommon here."

Lahaul (See Kulu). *Elevation* of the district : 10,000 ft. Chief village is Kailang (10,325 ft.) *Temperature* : 24°F to 63°F. *Season* : May to October. Dry, cool, invigorating. *Cases suitable* : Phthisis and other chest complaints.

Lanauli (Punjab)—Same conditions as at Khandala but fresher, as it is less sheltered by hills.

Landour (Dehra Dun) : *Elevation* : 7700 ft. Much exposed to wind and 4°F cooler than Mussouri, of which it forms a part.

Mahabaleshwar (Bombay). *Elevation* : 4,500 ft. *Temperature* : 40° to 89°F—more or less equable ; sea breeze blows from March to June. *Rainfall* : 250 in. *Seasons* : March to June (with sea breeze) and October to January. *Cases suitable* : Malaria, general ill-health, indigestion. *Cases not suited* : Phthisis, liver diseases, rheumatism, bowel complaints.

Matheran (Thana, Bombay Presy.). *Elevation* : 2,460 ft. *Rainfall* : 250 in. *Temperature* : 70° to 90°F. *Seasons* : April and

May and October to November. Sea breezes occur from March to June. Very damp during the rains. *Cases suitable*: General ill-health and children.

Murree (Punjab). *Elevation*: 7,500 ft. *Drainage*—good. *Rainfall*: 56·6 in. *Temperature*: 24° to 75°F; snow falls in winter. *Season*: September to December. *Diseases*: Bowel complaints, rheumatism, fever &c. *Cases unsuited*; Cardiac diseases.

Mussouri (Dehra Dun Dist.). *Elevation*: 6500 to 7000 ft. It forms with Landour practically one town. It is dry before the monsoons. *Rainfall*: 100 in. *Cases suitable*: Early phthisis, malaria, hepatic diseases, indigestion. *Cases unsuited*: organic diseases of heart, liver and kidneys.

Naini Tal.—See p. 379. **Nassik.**—See p. 378.

Newara Eliya (Ceylon). *Elevation*: 6,240 ft. *Climate*: Damp (∴ sedative), cool (somewhat equable). *Rainfall*: 98·9 in. *Humidity*: 73 to 88%. *Cases suitable*: General ill-health, insomnia, neurasthenia. *Cases unsuited*: Phthisis, hepatic disorders.

Nilgiris (Madras). See p. 379. *Elevations*: Dodabetta, 8622 ft.; St. Stephen's Church Hill, 7429 ft.; Snowden, 8299 ft.; Club Hill, 9036 ft. *Rainfall*—slight but practically present all the year round. January, February and March are the only dry months. *Temperature*: 38°F to 75°F. *Cases suitable*: Malaria, neurasthenia, dyspepsia, children. *Cases unsuited*: Phthisis, hepatic, cardiac and intestinal troubles (diarrhœa, dysentery).

Ootacamund.—See p. 379 under Nilgiris.

Pachmari (C. P.) *Elevation*: 4000 ft. *Temperature*: 56° to 94°F. *Rainfall*: 78 in. The rainy season is slightly foggy. *Humidity*: 57%. *Season*: October to December. *Cases suitable*: Children, phthisis. *Cases unsuited*: hepatic or bowel disorder.

Panchgani (Bombay)—12 miles below Mahabaleshwar, but less cool and with less rainfall.

Quetta (Baluchistan). *Elevation*: 5500 ft. *Climate*: Dry, healthy. *Temperature*: 40°F to 77°F. Summer season is cool and delightful. *Humidity*: 47%. *Rainfall*: 9 in. *Cases unsuited*:

those who are weak or liable to pneumonia or pleurisy. *Cases suitable* : Phthisis (during summer), liver and bowel complaints. See p. 381.

Ranikhet (U. P.). *Elevation* : 6000 ft. *Temperature* : 46°F to 78°F. *Rainfall* : 50 in. *Climate* : healthy moist and foggy during the rains. *Cases suitable* : malaria, general ill-health. *Cases unsuited* : Liver, kidney and heart diseases.

Shaikh Budeen (N. W. F.) *Elevation* : 4604 ft. *Temperature* in summer : 88° to 94°F. Cold breeze blows in summer. *Rainfall* —scanty. *Climate*—intensely dry and like that of a desert, with occasional light dust-storms. *Cases suited* : phthisis.

Shillong (Assam). *Elevation* : 4900 ft. *Rainfall* : 80 to 120 in. *Temperature* : 34° to 82°F. In winter, water freezes ; in summer, it is never too hot. *Season* : October and November. *Diseases* : malaria (rarely) and hill diarrhœa. *Cases suited* : General ill health and children. *Cases unsuited* : Phthisis, hepatic, cardiac, intestinal troubles. See p. 384.

Sanawar (Punjab).

Simla (Punjab). *Elevation* : 7000 ft. Jako, 8048 ft. *Temperature* : 24° and 93°F. *Rainfall* : 56·6 in. The water-supply is deficient in exceptionally dry weather. *Climate* : Damp, healthy. The summer is cool and dry ; the rains, misty and cloudy ; the winter, bright, dry and bracing. *Season* : Autumn. *Cases benefitted* : General ill health. *Cases unsuited* : Chest troubles, phthisis, rheumatism, asthma, bowel complaints, heart, kidney or liver diseases.

Solan—Same climate as that of Simla, *q. v.*

Spiti (Punjab) : *Elevation* : 12000 ft. *Climate* : sunny, dry and bracing. *Rainfall* : nil practically. *Temperature* : 14° to 63°F.

Subathu (Punjab). *Elevation* : 4500 ft. *Season* : October to December. *Temperature* in summer—90°F. Climate is not so healthy.

Sukeswar (Punjab). *Elevation* : 5010 ft. *Temperature* in summer : 106°F. *Rainfall* : 9·9 in. *Cases benefitted* : dysentery, phthisis, rheumatism.

Sultanpur (U. P. *Rainfall* : 40 in. *Temperature* : It is the hottest place in the Kangra Valley. From December to February —snow falls. *Season* : October to December. See p. 383.

Thandiani (Peshawar) *Elevation* : 9000 ft. It is the most elevated of the Indian stations and is extremely beneficial to individuals suffering from tropical asthenia and malaria.

Yercaud (Madras)—on the Shivarai Hills—is a low elevation, healthy.

(F) OTHER SANITARIA IN ASIA :

Malay peninsula.—Taiping Hill (2000 to 4000 ft), Gonongkerbau, the Gaf (2000 ft.), Bulitt Kutu (4000 ft), Magnolia Bay.

Penang : Penang Hill (3000 ft.)

Java.—Buitenzorg or Sindinglaia (6000 ft.) or Soekabumi (3000 ft.) or Preanger.

China : Hong Kong (peak, 1400 ft). Wei-hai-wei, Chefoo, Peitaiho, Western Hills, Kuling (6000ft).

Japan : Miyanoshita (Yokohama), Nikko, 2000 ft. (near Tokyo), Chuzenji (1300 ft.)

Australia : Leura, (3300 ft.), Toowoomba (2000 ft), Dalby (1800 ft), Tasmania, Brisbane, New England district (4000 ft.), Kiandra Mountains, Cooma.

Africa : Ceres (1493 ft.) in Cape Colony, Cradock (2856 ft.) and Matjesfontein (2970 ft.) in the Central Karroo, Kimberley (4000 ft.), Johannesburg (5690 ft), Basutoland (10,000 to 12,000 ft), several places in Natal, Pietermaritzburg (2200 ft.), Harrismith (5250 ft.), Salisbury (4700 ft.), Buluweyo (4250 ft.), Namirenbi or Mengo (5000 ft.), Mtonya (3500 ft.), Nairobi (7000ft.), Lebanon Mountain, Luxor, Assouan, Helwan, the Pyramids, Erkowit (3500 ft.), Sinkat (2700 ft.), Teneriffe Is. (1000 ft.).

CHAPTER XXVII.

THE CONTAGIA.

In this part of hygiene we deal with communicable diseases. The diseases dealt with are due to *contagia*. A **contagium** is a microbe, by means of which, a communicable disease is transmitted from the diseased to the well. It was formerly held that, certain diseases were communicable only by direct contact (**contagious**) with morbific matter ; and that others were aerially communicable (**infectious** or **infective**). Communicable diseases occurring in epidemics were called **zymotic**. We now know that all so-called contagious diseases are **infectious. i. e. caused by microbes,**—which are microscopic living particles, organized in structure and capable of independent life within, as well as without, the human body.

Infection now-a-days means the introduction into the body of a pathogenic microorganism, which is capable of multiplying within it. These microorganisms, while inside the body, produce a poison called **toxin** and the poisoning of the system by the absorption of chemical agents generated by germs, produces what is called **intoxication.** Study of communicable diseases, therefore, resolves itself into study of the life-history of microorganisms.

Classification of Microorganisms :—Living organisms generally, are either (A) Animal or (B) Vegetable. **Animals** are divided into (I) Vertebrata and (II) Invertebrata. These latter are divided into (1) Molluscs, (2) Arthropods, (3) Echinoderms, (4) Vermes, (5) Cœlenterates, (6) Porifera and (7) Protozoa or primitive animals. **Vegetables** are classified into

(I) Phanerogams and (II) Cryptogams or nonflowering plants. These latter are divided into (1) pteridophyta, (2) bryophyta and (3) thallophyta.

We tabulate them below :—

Protista or Protists.

(A) **Vegetable**—Protophyta or Thallophytes
  *1. Euphyceæ or algæ
  *2. Eumycetes or true Fungi
  3. Saccharomycetes or Yeasts
  *4. Diatomaceæ
  *5. Myxomycetes or slime moulds
  *6. Myxobacteriaceæ
  7. Schizophyta
    (*a*) Schizomycetes
    (*b*) Bacteriaceæ
      (i) Cocci (spheres)
      (ii) Bacilli (straight rods or cylinders)
        (α) Vibrios (curved rods)
        (β) Spirilla (twisted rods)
        (γ) Spirochætes
    (*c*) Schizophyceæ
    (*d*) Cyanophyceæ
(B) **Animal**—Protozoa
  1. Rhizopoda, gymnomyxa or sarcodina. Example : entamoeba histolytica.
  2. Flagellata or Mastigophora. Example—parasite of sleeping sickness
  *3. Ciliata
  *4. Suctoria or Acinetaria
  5. Sporozoa. Example, malarial parasite.

The following points are to be borne in mind in regard to germs :—(1) At the lowest part of the ladder of life, the animal merges with the vegetable, and one does not know whether a particular organism belongs to the animal or vegetable kingdom. Hence the name *protista* has been coined.

(2) Certain ultra-microscopic organisms exist, which are filter-passers, invisible with the highest present powers of the microscopes; they are called *chlamydozoa.* (3) Members of schizophyta group have many characteristics in common, which unite them into one continuous series. (4) All microorganisms are not harmful to man. The bacillus coli helps digestion in the cæcum; the smegma bacillus, the streptothrix buccalis, the trichomona vaginalis normally inhabit the human body without doing any harm, if not to the good of the host. Except in mid-ocean, in the expired air, in the air at high altitudes, in the water of deep Artesian wells, in the tissues of normal animals and plants (save the alimentary canal of all animals but dwellers in the Arctic), bacteria are found everywhere. Nitrification of the soil, ripening of cream preparatory to butter-making, formation of dadhi, cheese, koumiss &c., working of septic tanks, baking of bread, production of alcohol from saccharine juices, conversion of cane sugar into glucose, fat-splitting—are all the work of beneficient microorganisms.

Diseases produced by microorganisms :—*By Protozoa*: Malaria, dysentery. *ByMoulds* (hyphomycetes):—Herpes, thrush, favus, occasionally pneumonia, endometritis, cancer.(?) *By Streptothrices*—actinomycosis, Madura foot. *By Bacteria*: anthracosis, cholera, cerebrospinal fever, diphtheria, erysepelas, glanders, gonorrhœa, leprosy, influenza, Malta fever, malignant oedema, plague, pneumonia, rhinoscleroma, relapsing fever, sorethroat, suppuration, tuberculosis, tetanus, typhoid &c. [**Diseases of animals common to man** are: Anthrax, actinomycosis, diphtheria, erysepelas, foot-and-mouth-disease, glanders, malignant oedema, plague, tetanus, tuberculosis].

Propagation.—In the pre-germ days, diseases were considered to be either contagious or infectious. *Now* we know, that they are *all* infectious,—not in the sense of aerial transmission, but in the sense that such diseases are due to germs. The further important discovery has been made that, persons and animals cured of infectious diseases, harbour the germs of those diseases, in their body for months after their recovery and serve as **"carriers"** of disease, ready to infect others. Communicable diseases are transmitted, (*a*) *Aerially*, by exhalations, cutaneous desquamations, dried sputa or excreta ; (*b*) *Alimentally*—*i.e.*, by food or drink ; (*c*) *Fomitally*—*i.e*, by the agency of inanimate objects like clothing, furniture, letters &c. ; (*d*) *Tellurically*—via the soil ; (*e*) *Corporeally*—man to man or animal by contact ; (*f*) *Spread by "carriers"*—is now-a-days recognized as the commonest and surest means of propagation.

Those communicable *aerially* are : Tuberculosis, small-pox, plague, anthrax, leprosy (?), erysepelas, dengue, measles, whooping cough, diphtheria, scarlet fever, chicken pox, influenza, puerperal fever, epidemic pneumonia, mumps, tetanus, actinomycosis, glanders, hydrophobia, cerebrospinal meningitis. Those by *fomites* : malaria, filaria, elephantiasis, yellow fever, sleeping sickness, kala azar, oriental sore. *Intestinally :* diarrhœa, dysentery, cholera, typhoid, sprue, tuberculosis, typhus, Malta fever.

A disease is **endemic** when it is confined to a particular area and more or less constantly present, owing to local circumstances ; **epidemic,** when it is not locally confined and affects a large number of persons ; **pandemic**—when an epidemic disease simultaneously spreads over a large area of the earth's surface ; **sporadic**—when scattered but having the power to become epidemic.

ELEMENTARY BACTERIOLOGY.

Explanation of some terms.—*Bacterium* = a rod shaped vegetable microorganism ; now it is applied indiscriminately to all microorganisms, regardless of their shape. *Bacillus*=rod shaped vegetable microorganism. *Microzymes*, *Contagia*, *Germs*, *Schizomycetes*, *Microorganisms*, *Protists*, *Bacteria* or *Microbes*=minute forms of animal or vegetable life.

Morphology or structure.—Bacteria are made up of (*a*) *protoplasm*, which is semifluid and refractile ; (*b*) *nuclear material* or chromatin (but no actual isolated nucleus)—diffused in the protoplasm or, in some cases, aggregated in granules towards the end of the body ; (*c*) *cell membrane*—made of cellulose ; and, in some cases, (*d*) *fat*, *pigment granules* &c.

Bacteria occur either *free*, as *filaments*, in layers or in *cube-like* packets or as *zooglœa*. This zooglœa is a stage in their life history, in which the bacteria lie embedded in a gelatinous matrix secreted by themselves. In **size,** a bacterium is $\frac{1}{50000}$ to $\frac{1}{5000}$th inch. in **weight** $\frac{1}{64}$th grain.

Reproduction—is by two means : (1) By *Fission*—the germ dividing at right angles to its longitudinal axis, or longitudinally, or in both directions. (2) By *Spore formation.*—This is either *endogenous*, when the protoplasm becomes condensed, granular and like a bright spot within the condensed cell wall ; or *arthrospore*, when one among several microorganisms survives its fellows and produces a **spore,** which latter, under favourable conditions, can reproduce the microorganism. [Spore formation, like encystment of certain protozoa, is a *protective* rather than a reproductive effort. Spores are seen only among bacilli. They resist drying and very large alterations of temperature, in some cases, even boiling and the action of weak antiseptics ; certain spores frequently found in the soil resist boiling for 6 to 8 hours.]

Growth.—Variations in food supply, simultaneous increase of their own excretions (toxins), opposition of other living creatures, changes of climate &c. help to **retard growth** of germs.—In 24 hours, a single bacterium can develop to the number of 75,000,000,000,000, since they grow every 20 to 30 minutes. [**Processes inimical to bacterial growth** are: (1) Violent movements, *e.g.*, agitation. (2) Electric currents. (3) Exposure to sunlight or electric arc-light. (4) Excessive heat, specially moist heat. (5) Drying. (6) Deprival of food and oxygen. (7) Cultivating more than one species together. (8) Alternately freezing and thawing.] **Growth is favoured:** (1) by *Moisture.*—Drying kills most bacteria but not their spores. (2) By *warmth*: At 37°C they thrive best; cold retards their activity and growth but does not kill them; at 5°C and 45°C, their growth is arrested and heat over 60° to 65°C kills most of them. Spores resist dry heat but not boiling. (3) By *food*—Germs absorb carbon from albumen. Bacteria do not assimilate carbon from atmospheric CO_2—the majority of them give off CO_2 like animals. (4) By *oxygen.*—Bacteria that require oxygen for their existence are called ærobic; those not requiring oxygen are called anærobic. *Obligate ærobic*—are bacteria which can live only in the presence of oxygen; *facultative aerobes*—have or can develop the power of obtaining their oxygen from the medium in which they are cultivated, specially from proteids and carbohydrates. There is but a single anærobic micrococcus known—all other anærobic bacteria are bacilli. (5) By a slightly *alkaline* or *neutral* reaction of the medium.

Other properties of Bacteria.—(1) Some of them are **motile** with the help of *flagella* (placed at the ends) or of *cilia* (placed at the sides) or other unknown agencies. (2) They can be cultivated (**cultured**) artificially on—blood serum, milk, meat broth (bouillon), gelatin or agar (nutrient jelly), potato, bread paste, dead animal tissue &c. (3) They take on aniline **stain.**

Toxins are highly complex chemical bodies produced within the bacterial cell. They are unstable compounds, which are injured by heat, light and various chemical agents. They are not ptomaines, basic substances nor proteins.

Cultural characteristics.—While in artificial culture-media, the bacteria show certain diagnostic characteristics, *viz.*,

(1) In fluid media, some produce—(*a*) *Turbidity.* (*b*) A *scum* on the top. (*c*) A *deposit* at the bottom.

(2) In jelly, *liquefaction* is caused.

(3) Some are *chromogenetic*, thus—the colour Red—is produced by Bacillus prodigiosus, Orange—by Sarcina aurantiaca, Yellow—by Micrococcus flavus, Green—by Bacterium Viridis, Blue—by Pseudomonas Syncyanea, Indigo—by Pseudomonas indigofera, Violet—by Bacillus violaceus.

(4) Some produce light—(*a*) bluish appearance=*fluorescence*, (*b*) bright light=*phosphorescence.*

(5) *Coagulation* of media—as curdling of milk.

(6) *Fermentation* and *putrefaction.*

Classification : (1) **According to their Nature.**—Bacteria that can lead a separate existence are called *Saprophytes* ; those that live on or in higher bodies are *parasites* ; parasites that have not yet been cultivated outside their hosts, are called *obligatory parasites* ; bacteria which usually live outside but can be made to live inside a host, are called *facultative parasites. Obligate Saprophytes* cannot exist as parasites, *facultative Saprophytes* can. (2) **According to their Functions :** Aerogenic (gas producing), chromogenic (pigment producing), pathogenic (disease producing), photogenic (light producing), saprogenic (putrefactive), toxicogenic (poison producing) and zymogenic (fermentative).

Germ Diseases.—Germs exist on all sides of us, on our skin, in our oral mucous membrane and even in portion of the gastro-intestinal tract. But they cannot do us any harm, unless, by exhaustion, disease, fear or other depressing causes, inflammations or trauma, our tissue-resistance is lowered. If, during such a susceptible period, any disease germ enters our body, however minute be the quantity of the infectious material, we find the following **cycle of phenomena :** The germ either locates itself in one or other organ of our body or circulates in our blood. It takes some time (called *incubation period*) to attain maturity ; this done, it begins to *excrete toxins* or poisons, whose absorption by the system gives rise to diseases, with symptoms characteristic of each germ. (Hence, each particular disease is due to a pre-existing disease caused by identical germ, and is thus *specific*). The onset of symptoms is with "fever" ;—hence, fever now usually means an infection. As soon as toxins are manufactured and absorbed by the system, the latter begins to *manufacture antibodies* and thereby either kill off the germs or neutralize the toxins. When the person is recovering, by his body discharges he *eliminates the infectious germs* and very often one attack gives *immunity* to the sufferer against further attacks by the same disease.

Koch's rules.—In order to find if a certain microorganism is or is not the cause of a particular disease, Koch requires the following conditions to be fulfilled by the disease :—(1) The microorganism must be *found* in the blood, lymph or diseased tissues of man or animal, suffering from or dead of the disease. (2) This microorganism must be isolated from the blood, lymph or tissues and *cultivated* in suitable media *outside* the animal's body. These pure cultivations must be carried on *through successive generations* of the organism. (3) A pure cultivation thus obtained must, when introduced into the body of a healthy susceptible animal, *produce the disease* in question. (4) In the inoculated animal, the *same micro organism* must again be found.

PROTECTION AND IMMUNITY.

Phases of Protection.—We see in an epidemic, that (*a*) some escape and remain *healthy* : in them the resisting power of the body is efficient ; (b) others are *affected and die* : in them the resistance fails ; (*c*) others *recover spontaneously* ;—in them, resistance, at first weak, is later on reinforced ; (*d*) others suffer with a *chronic, localized disease*—in whom the natural resistance is unable to extinguish the infection locally.

What is natural resistance?—It is the power of the body to protect itself against, and rid itself of, microbic infection. [Inflammation is an effort of the immunizing mechanism to bring to the point of infection, through hyperæmia, a continually replenished supply of phagocytic cells and of opsonin.] The means at our disposal for this purpose are :—

(A) Primary or General (*i. e.*, acting against all bacteria) : It comprises three agencies viz.,—(1) *Opsonin*—which prepares bacteria for phagocytosis. (2) *Alexin*—which is produced by disintegration of leucocytes and which are bacteriolytic. (3) *Phagocytosis*—the really active, combative and absorptive agent, actively engaged in bacterial destruction. The phagocytes are of two classes—(*a*) Fixed cells of the body—like those of bone marrow, splenic pulp, endothelial cells, muscles, nerves &c. ; and (*b*) Wandering cells—specially the mononuclear and polymorphonuclear leucocytes-

(B) Secondary and Specific—*i. e.*, found only in infections by typhoid, colon, cholera and certain other bacteria. This is effected with the help of chemicals (called *antitropins*) that are generated in the blood (or perhaps in the connective-tissue-cells) as the result of specific bacterial invasion. It is impossible to isolate them. They comprise—(*a*) Further Opsonin—to stimulate more phagocytosis. (*b*) Agglutinin—to clump together the bacteria. (*c*) Precipitin—to cause a sedimentation of the bacteria. (*d*) Bactericidin—to kill bacteria. (*e*) Bacteriolysin—to dissolve bacteria.

How the defences act.—We have to remember at the outset two sets of opposing activities: (1) A set of *bacteria* entering the body and trying to multiply increasingly therein; and (2) the cells of the body straining every nerve *to keep themselves free* from the killing bacterial activities. Bacterial activity, again, is of a two-fold character. Bacteria create mischief either by their very *rapid multiplication*—as in the cases of tuberculosis, leprosy, glanders, anthrax &c.; or by means of their *toxins*—as in the case of diphtheria, cholera, tetanus &c. In the case of plague, influenza, septico-pyæmia &c., we have both factors to contend with-

As soon as bacteria enter the body, the **primary defences** are called up. They consist chiefly of two lines of defence :—(*a*) By means of a chemical, called *Alexin*, which has a destructive effect on bacteria generally and all cells foreign to the body. It is an unstable, soluble proteid, mainly derived from eosinophile leucocytes. A given quantity of serum contains only a certain amount of alexin, which can destroy only a certain number of bacteria—the alexin is destroyed by contact with which. (*b*) By *phagocytosis*—i. e., the power that certain body-cells have of engulfing, digesting and absorbing bacteria. The power to do so, resides in the leucocytes and the fixed cells of the body; but this phagocytic action is not called forth unless the bacterial cells are mixed with a chemical called *opsonin.* Opsonin is present normally in serum and its quantity is increased by presence in blood of bacteria. It is important to remember that opsonins have no power of stimulation on leucocytes but that opsonins render bacteria palatable to leucocytes, by mixing up with the former. Opsonins have no power by or in themselves to kill bacteria. The primary defences are bacteriotropic, and are effective against all kinds of bacteria. Sometimes bacteria may outlive these immunity-producing forces, producing what are called *resistant strains* (compare encysted form, and spore stage) and are called into being from the very first, but are as a rule not very strong in all cases.

[Based on these primary defences there are three theories, *viz*, (*a*) *Cellular Theory* (Metschnikoff) which supposes that fixed and wandering cells of the body have the power in them and by themselves of disposing of bacteria. (*b*) *Humoral Theory*—which assumes that the blood serum (and not the body-cells) possesses bactericidal properties—a purely protective function. (*c*) *Alexocyte Theory*—which conceives of alexins as proteolytic enzymes, derived from leucocytes (and not from serum) with the power of actually dissolving organized substances entering the blood.]

In the case of typhoid, colon, cholera and certain other bacterial infections (but not in all kinds of bacterial infections), the **secondary defences** or antibactericidal actions are called up. The chemicals, called antitropins, that thus appear in blood are, except in the case of opsonins, and the 'complement' in case of bacteriolysin, not found in that state in the blood; they are probably derived from connective tissue cells and each of them is specific for the same kind of bacteria that call them forth; and they owe their existence as such to bacterial invasion of the body. Introduction of bacteria or of their products excites in the body what is called the NEGATIVE PHASE, which is characterized by an impoverishment of the blood in antitropic substances—∴, increased susceptibility to bacterial infection or toxins. This is succeeded by the POSITIVE PHASE, in which the blood is full of antitropic substances and ∴ resistant to bacteria and toxins. Then succeeds a stage of slightly lowered bacterial resistance—and this persists for some time. The Antitropins are as follow :—

(1) **Opsonin.**—They are present in very slight amount in blood; bacterial invasion of blood or injection of dead cultures into the blood cause increase of opsonin in blood; thus there are two types of opsonins—the one, of normal serum, which is non-specific; the other, of immune serum, which is specific for each kind of bacterium and is a real antibody, being also thermostabile. The nature of opsonins is uncertain. By comparing the average number of specific microbes engulfed in a phagocyte from the blood of a patient, to the number engulfed in a phagocyte from the blood of a normal healthy person, we get the *opsonic index.* This is determined from two mixtures—(*a*) a mixture of normal serum, normal corpuscles and bacterial suspension; and (*b*) a mixture of serum of a patient suffering from an infection, normal corpuscles and bacterial suspension. This index is a guide, not to the degree of immunity, but to the evidence of response of the systemic resisting power of the patient, against specific disease germs. The **normal index** is usually 0·8 to 1·2. During the negative phase, the index is lowered, to be increased during the positive phase.

(2) **Agglutinins.**—They are probably distinct from immune bodies, because, bacteria are not killed by agglutination, but are simply rendered non-motile, and sera which are strongly antibactericidal, may be feebly agglutinative, and vice versa. They are thermostabile and used up in the process of agglutination—*i. e.*, in the process of clumping together of bacteria, hitherto existing diffused through an emulsion of them, when that emulsion is added to a corresponding antibacterial serum. Agglutinins act upon dead as well as living bacteria. The **clinical significance** of these reactions is: (*a*) the presence or otherwise of certain bacteria in the system; and (b) differentiation of bacteria found in various lesions. Agglutination is specific for specific bacteria; but, occasionally, group-reaction

(*iso-agglutination*) is exhibited; thus, a typhoid-immune-serum clumps b. typhosus quickly, even in 1 : 1000 dilution and b. paratyphosus slightly (in 1 : 100), b. coli in 1 : 30 and b. cholera in 1 : 10. [*Hæm-agglutinins*, produced by inoculating one animal with the red blood corpuscles of another species, cause clumping of red blood corpuscles, just as bacterial agglutinins do with bacteria].

(3) **Precipitins**—are specific substances produced in one's blood, when one's blood receives an injection of (*a*) a particular microorganism or (*b*) a solution of animal or vegetable albumin. The precipitins are, within limits, specific,—causing precipitation or cloudiness in a culture-filtrate of that specific microorganism or that albumin. Precipitins are probably not bactericidal.

(4) **Bacteriolysins.**—If we take an animal, by means of carefully regulated, frequently repeated, progressively increasing doses of a bacterial poison, we can increase its resisting power to an extreme degree. The blood of such an animal is not only anti-*toxic* against the specific poison injected, but is also *bacteriolytic*—i. e., it can dissolve those specific bacteria that have been used to excite the formation of the chemical —bacteriolysin. The actual solution of bacteria is accomplished by (*a*) a substance always present in normal blood and called—*complement*, alexin, cytase, lysin, addiment; this is thermolabile (i. e., is destroyed at 55°C); AND (*b*) another substance which is not normal to blood and whose presence may result solely from experimental manipulation, called—*amboceptor*, copula, immune body, desmon, fixateur &c.; this is thermostabile (*i.e.*, is not destroyed at 55°C). This amboceptor is a specific substance with almost specific action. It is produced in consequence of the immunization and its presence is the occasion of the solvent action exerted by the complement. There are, thus, two inseparable and interdependent

partners in the work of bacteriolysis—the specific amboceptor (present only in the serum of an immunised animal) and the complement (present in the serum of both normal and immunized animals). In practical application, specific bacteriolytic (or cytotoxic) sera have not been therapeutically efficient, because, no means have yet been devised to increase experimentally the complement, by whose co-operation alone they can become active. Nor are all bacteria subject to bacteriolysis.

[**Hæmolysins**—are thermostabile amboceptors like bacteriolysins and are specific for the red blood corpuscles, in response to which they are produced in the serum of an animal so treated. They are of value in regard to the Wassermann test for presence of syphilis, in carrying out which, one requires—(*a*) the patient's serum, (*b*) complement (fresh guinea pig serum), (*c*) red blood corpuscles, (*d*) hæmolytic amboceptor (serum of a rabbit which has been injected with the washed red blood corpuscles of a sheep) and (*e*) an antigen—*i. e.*, a substance which when introduced into an animal's body, gives rise to the formation of an antibody—*e. g.*, alcoholic extracts of normal organs; a toxin, a bacterial emulsion, a bacterial extract, an emulsion of blood corpuscles, a solution of albumin—may act as antigen.

(5) **Antitoxins.**—Wherever bacteria grow, they give off certain bodies called *toxins*. When these are formed within the body of the bacteria they are called *endotoxins*; when secreted from the body into the medium in which the bacteria are growing, *exotoxin*.

Now, when toxin enters the body of an animal, antibodies called antitoxins are produced in that animal's blood. Each antitoxin is specific against only that toxin, in response to which it is produced—completely neutralizing the toxin, physiologically, rather than chemically. It is seen specially in cases of diphtheria, tetanus and bacillary dysentery; in most other infectious diseases, phagocytosis and antibodies, which assist or effectualize phagocytosis, are formed. Antitoxicity as a phenomenon of immunity does not depend on the antitoxin; and antitoxins are powerless against the bacteria themselves.

Immunity :—In its broad sense, *immunity* means exemption from disease; but, we use it to mean resistance to disease. *Susceptibility* means receptivity to disease. *Predisposition* or *dyscrasia* is abnormal susceptibility. Immunity is *natural*, when it is inherited; it is also *acquired* through various accidental conditions peculiar to the life of the individual. It is *relative*, when it exists up to a certain high dose of a poison, but fails with a higher dose; it is *absolute*, when it exists irrespective of doses; thus, a hedgehog resists the effect of serpent's venom upto a certain dose but no higher (∴ relative); while certain lower animals can feed on poisonous plants and roots ad lib. Immunity is *histogenic* when it depends on the tolerance of the cells; *hæmatogenic*, when on substances contained in the blood (alexins, antitoxins etc). It is *active*, when it results from actual previous infection of the animal; and *passive*—when the immunizing mechanism of the patient has little to do with the result produced by injection of antitoxin. The natural immunity, thus, is active and histogenic,—due to phagocytosis and bacteriolysis; acquired immunity, chiefly histogenic, consists in a large measure of the exaltation of a normally existing but feeble resisting power. Natural immunity is confined to certain races and individuals among men and certain species among animals. Thus, man resists cattle plague, fowl cholera, swine erysepelas; the Negroes resist yellow fever and malaria. Animals resist gonorrhoea, scarlatina, measles etc.

Ehrlich's Side-chain theory of immunity.—How immunity occurs, cannot be satisfactorily explained. Prof. Ehrlich's theory, not perfect nor universally accepted, however, affords the best explanation yet furnished. His theory is as follows :—In studying compounds like, say, Benzene, we meet with a ring with several CH molecules attached. Ehrlich conceives of cells as similarly possessed of hypothetic appendages called *receptors.* These receptors are combining or fixing processes, capable of uniting only with molecules possessing corresponding combining appendages called *haptophores.* (A) **For purposes of cellular nutrition**, the cell is supposed ordinarily to nourish itself through combinations formed by the union of haptophores and receptors. These side-chains or receptors are of three orders ; the *receptor of the first order*, which is a single haptophore group and can link toxin or food molecules ready for assimilation ; that *of seemd order*—has a haptophore group and another with some other property—digestive, agglutinative, preciptating etc. ; that *of third order*—possesses two haptophore groups, to one of which the food molecule anchors, while the other has affinity for some molecule possessing digestlve properties. Amboceptors are receptors of the third order. So far about its nourishment. (B) **Speaking of immunity**, we should bear in mind—(*a*) that in crude toxin, some of the toxin molecules undergo modification into less or non-poisonous toxoids ; their combining power may be equal to, greater or less than that of toxin ; (*b*) that molecules with stronger combining affinity can turn out those with weaker affinity ; (*c*) that the neutralization of toxin by antitoxin is a chemical process ; and (*d*) toxins and toxoid molecules have a combining arm called *haptophore* and a poisonous arm called *toxophore.* A cell receptor may get locked to a haptophore group or a toxin molecule. When this occurs, the toxophore group of the toxin molecule is brought into relation with the cell. In consequence, the cell dies or its side chain is destroyed. As soon as a side chain is thus destroyed, the cell grows new side chains, and several such destructions call forth quite a large number of side chains, in excess of the cell's needs and cast such side chains free into the circulation. When the haptophore group of a toxin molecule combines with any of these *free* side chains, the toxophore group becomes impotent and thus can do no damage to tissues. Antitoxin thus is simply blood serum containing large numbers of free side chains. (C) **In the case of hæmolysis,**—the immune serum contains free side chains (called into being by the red blood corpuscles of the injected blood). These free side chains constitute the amboceptor, which combine, on the one hand with red blood corpuscles (cytophile affinity) and on the other with the complement (complementophile affinity) whereby the latter is enabled to lyse the former. The cell, thus, is a lock, the amboceptor a key, the complement the hand which turns the key ; many hands may do this, but only one key will fit the lock.

Supersensitization, Paradox Reaction, Anaphylaxis, Allergie, Theobald Smith's phenomenon.—These refer to altered reactivity of an infected animal to a second injection with the same poison ; it is thus specific and when once established, **it lasts** for a *long period of time.* A first injection sensitizes the patient—the sensitization usually lasting 8 to 12 days—but it may vary with the size of the original dose. A second large dose given before the end of the incubation period, desensitizes the patient. The anaphylaxis is due to the toxic action produced by combination of antibodies with antigen. **This is avoided** *by* avoiding reinjections after the tenth day, as far as possible, and by not using any serum which is less than 2 months old (as, fresh serum is more toxic) *or* by using fresh serum after heating it intermittently. The *symptoms* produced are grouped as **Serum disease.**

Means of increasing natural resistance.—They are **general** (like hygienic and medicinal measures) *or* **local**, such as by inducing hyperæmia &c.—the object in all cases being to induce hyper leucocytosis. Details of these means :—

1. **Hygienic.**—*e. g.*, good food, plenty of air, sunshine, regular action of skin and bowels, exercise in the open &c.

2. **Medicinal** : (*a*) *Taken internally*—general tonics. (*b*) *Injected into the body* : Spermine, yeast nuclein, nucleinic acid, papayotin, emulsin, diastase, pilocarpin, deutero-albumose, cinnamic acid, bacterial culture filtrates &c.

3. **Local**—By massage, passive or active motion, heat application, surgical operation, deep breathing (in pulmonary tuberculosis), shouting (in laryngeal tuberculosis)—all of which cause local active hyperaemia ; by Bier's passive hyperaemia method.

Means of exalting Specific immunity.—These are two—natural and artificial. **Natural.**—When a man suffers from an infection and recovers, it means that his system has acquired immunity during the infective process, through formation of specific opsonins. Against some of the infections (*e. g.* typhoid, small pox), the specific immunizing mechanism retains its latent power for future occasions ; for most others (*e.* g., pneumonia, erysepelas, furunculosis), the persistence of specific opsonin (which apparently is the most important factor in immunity) is of brief duration—hence, relapses are common.

Artificial or Acquired.—It is effective only against the specific poison. This is obtained by (1) inoculation or by (2) serum injection. The former is called active or isopathic and the latter, passive immunization. *Active* immunization is protective, operative some time after the injection and is lasting in its effects. (A protective inoculation may however be successful even subsequent to infection, provided the infection is localized and chornic in its course—hence, the value of Pasteur's treatment of rabies after bite). *Passive* immunization is curative—operating at once, and is short-lived (8 to 14 days) in its effect.

Active Immunization (Vaccination).—The injection of pathogenic bacteria or their toxins into the body induces elaboration of antitropins. But, if the bacteria be virulent or the dose of toxin too great, the animal dies, before it can manufacture sufficient protective substance. It has been found that high temperature and other factors can attenuate the bacteria; and injection of such is not fatal to the animal, while fully capable of calling forth the protective substances. Any such substance, which when introduced into the body, induces the elaboration of protective substances, bacteriotropic or antitoxic, is called a **vaccine.** And immuization by injection of a vaccine is called *vaccination.* The vaccines used usually are :—(*a*) LIVING viruses that are *virulent* (as those of small pox, cholera). These are positively risky and therefore abandoned. (*b*) LIVING viruses that are *attenuated.* [This attenuation is effected by (i) exposing the germs to a *temperature* of 42°—43°C—as in the case of anthrax; (ii) *passing the germ through less susceptible animal*; thus, cow-pox is nothing but the variola of man attenuated by transference to the ox or calf; similarly, the germ of swine erysepelas, which becomes more virulent if passed through a pig, becomes less virulent on passage through pigeons; (iii) *drying the vaccine* as in the case of rabies; and (iv) *addition of a weak antiseptic*, as in case of anthrax.] (3) KILLED cultures.—Their use is safer and simpler as for example in cholera, typhoid, plague. (4) Bacterial CELL-SUBSTANCE which can produce active immunity; as in the case of tuberculin. (5) TOXIC FILTRATES of bacterial cultures.

Passive Immunization by using antitoxic sera **Serotherapy.**—This is specific. The (active) immunity obtained by an animal treated with a specific virus can be transferred to another animal (passive) by using the serum of the first. The sera used have only **anti-toxic** properties, as, in the cases of diphtheria, tetanus, plague, snake-venom, tuberculosis, where no bactericidal action is manifest; in the cases of typhoid, pneumonia and staphylococcus infections, **bactericidal**, rather than antitoxic, action is manifest; while in cholera, **both** kinds of action are seen. The immunity conferred is very gradual and capable of unlimited increase and transferable by suckling and inheritance to an offspring. The sera are standardized in "*units*," which vary with the nature of the sera. They are usually prepared by injecting healthy horses and the serum obtain is the defibrinated blood of such a horse.

Transmission of contagia: It is chiefly by man himself. The possible media are six:—(1) *Soil*: Bacteria not only do not multiply, but undergo positive extinction while in the soil, unless the soil is continually contaminated afresh with bacteria. (2) *Defective drains, sewers etc.*—In the absence of much splashing and bursting of bubbles, the sewer air contains very few bacteria, excremental bacteria being almost absent. (*c*) *Air*: Pathogenic bacteria do not multiply in air and air does not bridge over the gap between one epidemic and the next. (*d*) *Water.*—Most pathogenic germs tend to die out in water; but drinking polluted water gives rise to illness. (*e*) *Solid Foods.*—Uncooked vegetables, grown on sewage-infected soil or washed in polluted water, oysters grown in polluted water—are dangerous. (*f*) *Carriers.*—A man who has once suffered from say diphtheria or typhoid fever, remains for an indefinite period of time (in months or years) a potent disseminator of that infection. This means of transmission is now believed to be more potent and more certain and more numerous than the other means.

CHAPTER XXVIII.

CONTAGIOUS DISEASES.

Small Pox, Variola.

Distribution—Endemic in India, Soudan, London.

Incubation Period : 9 to 15 days.

Infectious from the very earliest appearance of symptoms to 3 to 4 weeks.

Virus resides in—*Secretions* of mouth and throat and skin eruptions, in the dried *epithelial* scales (scabs) and in pus. It clings to *clothes*, *beddings* etc.

How conveyed :—Probably, by direct contact of persons having the disease in a regular or modified (∴ undiagnosed) form ; also from cadavers. Prevailing winds convey it to long distances, but to the utmost extent within ¼ mile of centre of infection. Also fomitally (?)

The Virus ; Klein and Bay's Spore forming bacillus.

Incidence : Black races more affected ; so are males. Occurs between January to June, being virulent every fifth year in Calcutta. Unvaccinated adults are more affected than Vaccinated children.

Types—Discreet, confluent, hæmorrhagic or malignant.

Diagnosis from—Chicken pox, scarlet fever, measles, typhus, rubeola, cerebro-spinal fever, influenza.

Preventive measures : (1) *Isolate* the affected persons efficiently, promptly and at the earliest opportunity. (2) *Disinfect* the room and its contents, as well as the belongings of those who came in contact ; burn all rags. (3) *Revaccinate* all contacts and all children who have not been vaccinated or who have been once vaccinated but are over 14 years of age. (4) *Quarantine* the contacts or keep them under observation till beginning of third week from the date of revaccination. (5) Insist on *compulsory notification* on the part of physicians and householders to sanitary authorities and on the part of sanitary authorities to school authorities. (6) House to house *inspection* to find out suspicious and concealed cases. (7) During convalescence, patients should rub oil to *prevent crusts* flying about. (8) *Corpses* should be burnt rather than buried and that as soon after death as possible ; and corpses should be handled by vaccinated persons, after being covered with cloth soaked in 1 : 500 hydrarg. perchloride lotion. (9) Exclusion, *segregation* or forcible inoculation of all tramps or other persons entering pauper houses or casualty wards.

Vaccination,—with reference to variola, means inoculation with the virus of *cow* pox. It is a fact that, if lymph from *human* small pox vesicle is inoculated into a calf and material from the local lesion of that calf is inoculated into another calf and so on in succession, upto four calves, then the material taken from the local lesion of the fourth calf, when inoculated into human being, produces typical vaccinia (cow pox). And, if a person is vaccinated within 48 hours of his taking the variola contagion, he may be cured of variola. Vaccination (*i.e.*, inoculation with virus of variola attennated by its passage through calves), thus, is intended to render human beings immune to small pox. That it does so, is *proved* by (*a*) persistence of small pox among the unvaccinated ; (*b*) transference of incidence of variola from inoculated children to adult males ; (*c* immunity of nurses and doctors who frequently vaccinate themselves ; (*d*) stamping out of variola from Germany, where vaccination and revaccination are both compulsory, and persistence of variola in India, China, Austria and Belgium, where vaccination is not compulsory. RULES FOR VACCINATION

—Every child should be vaccinated within a year of its birth. *Primary* vaccination is best avoided before a child has cut his first tooth—say, sixth month. Four successive points should be made. Every adult should be *revaccinated* at the age of puberty and whenever there is an epidemic, or every fifth year. Vaccination should be performed under aseptic but never under antiseptic conditions. Glycerinated, lanolinated or chloroformed calf lymph should be used rather than arm-to-arm vaccination be allowed. SUCCESSFUL VACCINATION is indicated—if there be present at the site of inoculation—a red areola around the vesicle, depressed centre of each vesicle, translucent, pearly colour of each vesicle and deep scars, later on. *The Stages of Vaccinia inoculation* are: Papular stage—4 days, vesicular stage—6 to 7 days, crust formation—5 to 6 days and crust separation—5 or 6 days. DISEASES ATTRIBUTED TO VACCINATION :—syphilis, erysepelas, diarrhœa, tabes mesenterica, scrofula, bronchitis, cancer, leprosy, impetigo contagiosa, cellulitis, pyæmia, local gangrene. If syphilis does occur (which is rare) indurated chancre forms locally and rash appears 50 to 90 days after vaccination. Local inflammatory or skin troubles are due to carelessness or impurity of the lymph. The other diseases mentioned do not seem to have occured.

Scarlet Fever (Scarlatina).

Distribution—chiefly in Europe. Rare cases occur in India. **Etiology**—a variety of streptococcus.

Incubation Period—24 hours. Extreme limits—12 hours to 7 days. **Types**—Rudimentary, simple, malignant.

Diagnosis from : Tonsillitis, diphtheria, influenza ; rubeola, early variola, measles ; erythema, eczema and dry rashes, acute exfoliating dermatitis ; septicæmia.

Incidence : Females oftener attacked. Age : 1 to 10 years. Upto the 5th year, liability is less (than in the 5th year) but risk to life is great ; after 5th year, attacks are less frequent and less severe. Relapses are frequent but usually one attack confers immunity for life.

Infective for 6 to 8 weeks—starting with the acute febrile stage, during which it is most infectious.

Spreads by (*a*) *Air*—conveying breath and dried discharges from nose, ear, mouth, skin. (2) *Fomites*. (3) *Milk* handled by infected persons or from cows with infected udder-sores, (4) *Direct contact*. Surgical and puerperal cases are specially liable to attack..

To prevent spread : (1) *Isolate*—if desired, in one's own home. (2) *Quarantine* of suspects for one week. (3) *Notification to* health officer by householder. (4) Closure of schools. (4) Sterilization and better than this, stoppage of *milk*. (5) Proper *disinfection* of bedding, furniture, toys, books, faucial, nasal and oral discharges of patient. (6) Proper baths and rubbing of *oil* by patient. (7) Special care of puerperal and surgical cases. (8) Isolate for one week at house mild (and perhaps unrecognized) cases, cases freshly returned from hospital. (9) Prevent over-crowding and insanitation.

The Rash (1) Appears first on face and neck (2) It appears at first as minute, bright and slightly elevated points, so numerous as to produce a general redness of the surface. (3) It lasts 3 to 4 days.

Measles (Morbilli).

Distribution : universal. **Etiology**—unknown.

Incubation period : 4 to 14 days—usually, 9 to 12.

Eruption (1) Appears on 4th day, first on face, arms and neck. (2) Character : velvety, crescentic patches, slightly raised above skin. (3) Disappears within 3 or 4 days.

Types : Benign, hæmorrhagic, malignant, typhoidal.

Diagnosis from : Scarlet fever, small pox, typhus fever.

Mortality : greatest under 3 years of age and in the extremes of life. Overcrowding, insanitation, bad development and insufficient food and clothing increase the mortality.

Incidence : attacks specially children of both sexes in the first half of the year. Recurs frequently.

Contagium resides in : secretions of nose, throat, lungs.

Conveyed (1) Fomitally in garments, clothes. (2) Aerially—specially during catarrh stage. (3) Directly corporeally. (4) By cats (?)

Infectivity—specially in the pre-eruptive period, when catarrh only is present, till 3 or 4 weeks after disappearance of rash.

To prevent spread : (1) *Isolation* of sufferers at home for 3 to 4 weeks. (2) *Quarantine* of suspects for 16 days. (3) *Disinfection* of buildings, schools, libraries, fomites and patient (by oil inunction and bath). Destroy sputa and rags. Avoid overcrowding. Secure thorough ventilation, but protect from chill and draught. Exclude cats. (4) When measles occurs in *a school* or house, coughing alone and first signs of illness should cause the child to be isolated and watched. At the start of an outbreak, the measles history of each pupil should be taken ; those who have not had it before should be sent home.

Whooping Cough (Pertussis).

Distribution—specially in temperate climates.

Etiology : Bordet's bacillus ? **Incubation Period** : 1 to 3 weeks.

Mortality—great among infants (the younger the worse) and Negro races.

Incidence : Affects children specially (1-8 years) and females.

Infection resides in—pulmonic discharges. **Conveyed**: ærially, fomitally, corporeally.

Infectivity—commences from the catarrhal stage and lasts 6 or more weeks—from onset of cough.

Complications—Bronchitis, emphysema, hæmorrhages.

Diagnosis from: croup, laryngismus stridulus, bronchial catarrh, asthma.

Spread prevented by: (1) Isolation. (2) *Quarantine* of suspects. (3) *Educating* guardians and parents by means of pamphlets. (4) *Disinfection* of buildings, fomites, discharges and of nose and air passages. Free ventilation without causing chill. (5) During epidemics, *a child at school* that is ill or has simply cough should be sent home and watched. (6) Exclude *dogs*.

DENGUE.

Incidence—Hot season in the tropics specially affecting coast and river districts.

Etiology: McLaughiin's micrococcus (?)

Spreads: Aerially and by direct contact.

Diagnose from—influenza, yellow fever (with which Dengue is concurrent), rheumatism, malaria.

Prevent Spread by—isolation, notification.

Chicken Pox. (Varicella).

Distribution—in temperate climates. **Incubation period**: 11 to 19 days.

Eruption (1) Appears on second day of fever, on skin of back and shoulders, neck, breast and mucous membranes. (2) It appears at first as red papules which become globular vesicles.

Types: Simple. hæmorrhagic, gangrenous.

Incidence—children between 3 and 4 years, and in autumn.

Diagnosis from—Small pox, vesicular and pustular syphilitic eruptions, herpes, lichen, pemphigus, acne.

Conveyed—aerially, formitally and corporeally.

Prevent Spread by : (1) *Isolation* till all scabs drop off. (2) *Quarantine* of suspects for 18 to 21 days. (3) *Notification* to health officer. (4) *Disinfection* of room, fomites and patients' skin by oil and bath.

Mumps (Epidemic Parotitis.)

Incidence : Male children between 5 and 15 years of age, in spring and autumn. **Incubation period** : 14 to 25 days.

Infective—from the very beginning, till 3 weeks from commencement of glandular swelling-

Prevent Spread by (1) Isolation, (2) Quarantine, (3) Notification.

Diphtheria. (Membranous Croup).

Distribution—Chiefly in towns.

Etiology.—Klebs-Loeffler bacillus. [The pseudo-diphtheritic bacillus (of Hoffmann) is morphologically and culturally allied to Klebs-Loeffler bacillus—but is non-pathogenic, being probably a vegetative or attenuated form of the real bacillus]. When the diphtheria bacillus is associated with others (*e.g.*, streptococci, staphylococci), the type of diphtheria produced is septic and virulent. **Incubation period :** 2 to 7 days.

Contagion found in—the false membrane, the secretions of nose, fauces, larynx and, if it affects the vagina, oesophagus or recent wounds, then in their discharges too.

Diagnose from—Follicular tonsillitis, croup, scarlet fever, septicæmia. **Types**—Pure, septic.

Incidence—Chiefly affects female children (2 to 12 years) in autumn and winter. The younger the child, the more the fatality. Recurrences are common.

Spread by : (1) Air (by inhaling breath or wind-convection). (2) Milk—but not by water, however impure. (4) Fomites. (4) Corporeally—by mild or undiagnosed cases, or by carriers (convalescents), by 5 to 10% of children of the working classes.

Prevent Spread by : (1) *Notification*, (2) *Isolation*, (3) Regular bacteriological examination of throats of all cases admitted into fever wards. (4) *Quarantine* for a week. (5) Boil or better still, exclude *milk.* (6) Exclude *cats* and destroy them if affected. [Cows, pigeons, fowls, birds do not suffer from it.] (6) *Disinfect*—room and fomites by steam; and destroy all excreta from nose or throat; cremate dead bodies early. Drains should be disinfected, darkness, damp and dirt should be removed. Antiseptically wash throat and nose of patient. *Prophylactic inoculation* of contacts and suspects should be done. (7) *In schools*—regularly bacteriologically examine nose and throat of children; exclude children with enlarged tonsils and adenoids. Avoid cold, damp and wet. Persons with hereditary or family susceptibility should be removed. Avoid convalescents, until at least 14 days since disappearance of last trace of membrane. Puerperal women, convalescents from scarlatina and measles should be specially cared for. Filthy habits of cleaning slates with spit, using same cup to drink out of, transferring sweets from mouth to mouth—should be put down.

Typhoid Fever (Enteric, Gastric Fever.)

Distribution—everywhere.

Etiology—Bacillus Typhosus. The bacillus is non-spore forming; it grows aerobically and anaerobically. It is easily killed by heat but resists cold, sunlight and X-rays. The presence of bacillus coli, b. streptococci and other organisms, is antagonistic to the life of b. typhosus. The virulence of b. typhosus may be increased by association (symbiosis) with certain strains of b. coli, with the bacillus of Gaertner and with b. enteritidis sporogenes and b. carnis. Bacillus paratyphosus-A of Brion-Kayer and B of Schotmuller are intermediate culturally between b. typhosus and b. coli.

Incubation period : 12 to 14—but perhaps up to 23 days. It is shorter in aerial and longer in alimental infections.

Eruption : Rose coloured papules appear on abdomen on 10th day : they fade on pressure, to reappear when pressure is removed.

Types : Abortive, ambulatory, hæmorrhagic, low nervous, irritative with hyperpyrexia.

Diagnose from—malaria, pneumonia, typhlitis, ulcerative endocarditis, tubercular meningitis, general miliary tuberculosis, pyæmia etc. [Widal test (agglutinin) is answered by non-typhoid cases too. Real typhoid cases also may not occasionally answer to it. It is obtained after 10th day. This reaction is always in higher dilutions in urinary-carriers than in foecal-carriers]

Incidence : (1) Females more than males. (2) Age : chiefly between 15 and 25. (3) Rainfall.

Contagia found in (1) Blood—up to 10th day and in cases of relapse. (2) Spleen, Peyer's patches, mesenteric glands—when it disappears from the general circulation or blood. (3) Gall bladder and bile—after recovery or death. (4) Foeces—during incubation period and in the early days of the illness and during 3rd and 4th weeks (convalescence). (5) Urine—until end of second week. **Immunity**.—one attack confers immunity.

Spread by : (*a*) Air—bearing dried up stools laden with enteric germs. (*b*) Aliments *—specially, (i) water soiled by excreta of typhoid patients ; (ii) shell fish, celery and watercress cultivated in beds into which sewage from polluted area drains ; (iii) milk—adulterated with infected water ; (iv) cheese and other foodstuffs soiled with the feet or vomit of flies, vermins, rats and mice ; (v) ice-creams. (*c*) Fomites. (*d*) Corporeally—by soiled hands or by using the drinking utensil of typhoid patients or chronic carriers * or mild and ambulatory forms of cases and by contacts.

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* Epidemic due to milk usually dies at or about the end of the 2nd week after the arrest of the contaminated supply ; that due to public water-supply, at end of 4th week ; that due to well water, after a long, long time.

Prevent spread by : (1) Preventing pollution of soil, water and food supply. Efficiently sterilize food and drink. (2) *Inoculate* nurses and attendants with typhoid antitoxin and prevent their being simultaneously engaged elsewhere. This immunity lasts less than 2 years ; use of sensitized (rendered non-virulent) bacillary vaccine confers a longer immunity. Use nail brush and antiseptic lotions for the hands of attendants. (3) *Isolate* patient. (4) *Disinfect*—(*a*) his perinæum and buttocks after each motion ; (*b*) chamber pots and closet pans and seats—after each use ; (*c*) excreta—by burning them or treating every part of them with strong antiseptics—for at least 10 days after temperature is normal ; (*d*) drinking pots, bath tubs, hose pipes etc.

Epidemic Diarrhœa.

Synonyms : Dysenteric diarrhœa, enteric catarrh, gastroenteric catarrh, muco enteritis, zymotic or epidemic enteritis.

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* Carriers (who appear to be the best propagators) are (*a*) *Acute*—when they are in the period of incubation of the disease, excreting enormous numbers of b. typhosus in their urine and foeces for a fortnight before they are at all aware of their malady ; or they may be actual sufferers from ambulatory or a typical (children's) type of typhoid fever. (*b*) *Chronic*—who at some part or other of their life had the disease and some of whom harbour the germs for an indefinite period.

Etiology : B. enteritidis (Gaertner), b. enteritidis sporogenes, putrefactive bacteria—or several bacilli of coli type or Morgan's bacillus. **Incubation Period**—a few hours to 2 days.

Types : Simple (choleraic diarrhoea), dysenteric (with blood), icteric, pneumonic.

Incidence—(1) Two extremes of life chiefly affected ; hand-fed children (0—5 years) are specially liable. (2) Most prevalent in summer, (middle and end), reaching its maximum in August ; worst in dry seasons. (2) When the temperature of the earth at a depth of 4 ft is 56° F, its incidence is highest. (3) One attack confers no immunity. (4) Found in towns.

Spread by—tainted food,—specially milk, impure water, fouled (sewer) air, dust charged with horse dung or excreta of patients, food picked up from gravelly or marly soil or made ground or soil manured or soaked with sewage ; foods kept in underground cellars or in pantries to which sewer air has access.

Prevented by : (1) Domestic cleanliness—by mending defective drains, cleaning privies and gullies, removal of any slop or dry refuse the moment it is generated ; burn the latter. (2) Have sewers on the water-carriage system. (3) Protect food and drink from flies and dust. (4) Keep out flies by killing them, by destroying horse droppings, cowdung, human excreta, animal and vegetable refuse, indeed dirt of all kind. Keep fruits, sweets, milk, fish, meat &c.—all well covered. (5) Keep down dust—by paving streets and yards with impervious material, watering or oiling the streets. (6) Regarding children, avoid, (*a*) handfeeding them till 9th. month ; (*b*) weaning during summer months, specially if diarrhœa be prevalent ; (*c*) feeding bottles, dummy teats ; if used, at all, keep them scrupulously sterile ; (*d*) unboiled milk ; (*e*) condensed milk ; (*f*) allowing children to crawl about upon, and pick up food from, floors ; (*g*) thumb-sucking by children or rubbing children's gums to ease them, about their dentition period.

Tuberculosis.

Synonyms—Phthisis, Consumption. Lupus, Tabes mesenterica, tubercular meningitis, tubercular diseases of bones and joints, scrofula. **Distribution** : World-wide.

Etiology : Bacillus Tuberculosis. It is a thin, motile, non-spore forming rod, which resists putrefaction, drying, and X—ray but is killed by sunlight. It can live within and outside the animal body. [Pfeiffer's Bacillus Pseudo-tuberculosis, some aspergillus or streptothrix, actinomycosis—may produce caseating tubercles, which are not real tuberculosis].

Incubation period—uncertain. **Types**—Acute, chronic.

Incidence—all warm-blooded animals are affected and some cold-blooded animals too. *Goat* is very slighty if at all susceptible. Most prevalent in winter and spring. Children of phthisical parents or children with scrofula are specially liable.

Contagium found in—sputum chiefly of advanced cases, milk from tubercular udders, caseating nodules.

Spread : (1) *Aerially*—by inhaled dust infected with dried sputum of pththisical patients or with other discharges (pus, dried foeces &c.) containing the organism. Air of houses that are situated back-to-back or damp, dark, heated and overcrowded ; dirty occupations—specially in the case of persons who are ill fed, ill-clad (∴ exposed) or are alcoholic. (2) *Alimentally* from drinking milk from tuberculous udders, or eating meat of tuberculous cattle. (3) *Directly corporeally*—by coughing, infection of wounds &c. and by flies.

Prevention : (1) *Notification*, compulsorily, of all cases (especially early cases) of lung phthisis by patients, their guardians, employer or doctors or by staff of Anti-Tuberculosis Dispensary. (2) *Isolation*—early, of fresh and acute, apyretic cases, with small localized lesions, or of some selected chronic cases in sanatoria ; of chronic advanced cases in special hospitals or infirmaries ; and of all convalescent acute cases in special convalescent houses. (3)*Free Anti Tuberculosis Dispensary*—should be started for visiting in their homes cases that avoid hospitals and persist in pursuing their daily work, with a view to (*a*) studying the home conditions of the patient and teaching the members of the family precautionary measures against the spread of the disease ; (*b*) distributing spitoons charged with antiseptics and subsequently collecting them and bacteriologically examining their contents free of charge and giving the report to the patient and disposing of the sputum ; (*c*) instructing patients to keep all doors and windows open, day and night, in all weathers, but to avoid chill and exposure ; to sleep in a room by himself, to avoid spitting indiscriminately and to use separate cups, spoons, saucers etc. of his own ; (*d*) to supply free nurses and health workers, even food and clothing, if required, but no medicines (unless so requested by the attending private medical attendant ; (*e*) to keep itself in constant active touch (so as to secure admission of those who care) with local sanatoria, general medical and surgical as well as tubercular hospitals for advanced cases, After-care associations and the municipal health department and (*f*) to provide suitable occupation for cured cases (4) *Disinfection*—of houses recently occupied by phthisical patients. If patient has indiscriminately spat on walls and floor, it is better to replaster the walls, smooth down the flocr or recement it. Fomites should be repeatedly exposed to the sun's rays. (5) *Inspection of Foodstuffs.*—Dairy farms should be regularly visited by Veterinary inspectors and milch cows tested with tuberculin periodically (see p. 198) ; meat should be inspected and dairies and milk shops should be sanitarily supervised. Milk must be thoroughly sterilized before use and meat should be well cooked, (6) *Sanitary measures* :—(*a*) Spitting in public places or conveyances should be penalized. (*b*) All phthisical cases should report their movements to the sanitary authorities of the district. (*c*) The resorting of public eating and drinking houses by actively phthisical patients should also be penalized —specially smoking out of the same hubble-bubble. (*d*) Smoke and dust should be prevented. (*e*) The soil should be dried. (*f*) Dark, damp ill-ventilated rooms should be compulsorily opened up, to let in sunlight and air. (*g*) Open-air schools should be started. (7) *After-care of Sanatoria cases* : They should be provided with out-of-door occupations of a light nature. They should be allowed to live on sanitary premises (convalescent homes etc.) and not allowed to go back to their former squalor. Their sputum should be periodically examined bacteriologically and they should be instructed to observe hygienic measures—the same to which they got accustomed in Sanatoria.

Bovine & Human Tuberculosis—Though Koch believed them to be separate and not mutually inoculable, at any rate to a great extent, modern teaching is that though human tuberculosis is not so virulent to cows, bovine tuberculosis is very easily transmissible to man by milk and meat.

Tuberculosis Sanatoria : OBJECTS : (1) To cure early cases and thus lessen the danger of infection. (2) Separation and amelioration of symptoms of slightly advanced cases. (3) Training of patients regarding the danger of spitting. CONSTRUCTIONAL DETAILS :—*Climate*—low and equable with plenty of sunshine. *Soil*—clean and dry. *Aspect*—assuring ample air and maximum amount of sunlight. *Site*—on southern slope of a hill, sheltered from north and east winds by rising ground or trees (pine or eucalyptus or *neem*). It should be well away from dusty or main thoroughfares—as near railway station as convenient. *Ground required* is roughly one acre per each patient—so as to provide within the compounds for (*a*) occupations by inmates—gardening, poultry-farming, bee-keeping etc. ; (*b*) seats and promenade for those who can use them ; (*c*) disinfecting and incineration, post-mortem room and mortuary, dispensary and pathological laboratory, consulting room, office, surgery, bath, laundry and drying room, library, recreation room, ambulance, electrical engine house ; (*d*) a liberal supply of bath rooms—as bath forms an important part of the treatment. *Arrangement of blocks* :—It should be rather a collection of one-storied pavillions of winged form, at distance of 40 ft. from each other and raised 3 ft. from the ground, so as to secure free ventilation of air under floors. *Accomodation :* Roughly, there should be 1 bed for each 5000 of population and no sanatoria should have more than 100 beds. Each pavillion or ward should not contain more than 8 to 12 patients. There should be 1500 c. ft. of cubic space for each patient and 100 sq. ft. of floor area for each bed. Light should be electric, warming by hot water pipes ; but it is best to avoid steam or hot water pipes and to keep the room-temperature equal to the outside temperature, except in severe winter. There should be as many windows as possible, balconies and verandahs are to be avoided as they obstruct ventilation. Walls should be smooth and distempered ; unnecessary furniture is to be avoided ; floors should be teak or oak on concrete. *Medical attendance*—should be thrice daily, each doctor having not more than 40 patients to attend to.

Sanatoria in India.—*Bengal* has one at Darjiling. *Madras* has none. *Bombay has* one at Panchgani. In the *Punjab* there is one at Dharampur and in Patiala State there is a sanatorium and a hospital for advanced cases. *Indore state* has one. In the *United Provinces*, there is one in the Bhawali state.

Cases suitable for Sanatoria' : The first and second stages of phthisis as well as the pneumonic forms are best suited to Sanatoria treatment. The following cases are *unsuited to Sanatoria* treatment :—Patients who are nervous, irritable, sleepless ; patients with cavities, or with persistent high temperature or with organic heart and renal lesions or with tubercular laryngitis or ulceration of intestines or cases of fibroid phthisis.

Epidemic Influenza. (La Grippe).

Etiology : Pfeiffer's Bacillus—found in the sputum and nasal secretions. **Incubation Period** : 2 to 4 days.

Types : Gastric, Respiratory, Nervous.

Incidence—middle aged male adults are chiefly affected.

Spread—corporeally and fomitally specially in directions opposed to prevailing wind.

Infective—even during convalescence.

Prevent Spread by Isolation (if practicable), disinfection of sputum and of nasal discharges.

Gonorrhœa, Clap.

Etiology—the gonococcus present inside the leucocytes found in the purulent discharge. The cocci remain latent in the urethra for long periods. **Incubation** : 2 to 3 days. **Types** : Acute, chronic. **Spreads**—fomitally or by direct contact.

Prevention—by licensing and inspection of prostitutes ; by advising continence till gleet is cured ; by interdicting use of public baths or sanitary conveniences.

Syphilis, The Pocks.

Distribution—world-wide. Rare in animals.

Etiology : Caused by Leucocytozoon Syphilides, of which the spirochætæ, Treponema pallida, represent a phase in the life history. [The Treponema pallidum occurs alone in deeply seated lesions ; but in ulcerated surfaces, it is associated with spirochæta refringens].

Incubation Period : 3 weeks. **Types** : Congenital, acquired.

Recurrence : One attack confers immunity during the primary and secondary stages and for some time thereafter—but not life-long.

Transmitted—fomitally and directly corporeally [Milk, tears, sweat, semen and saliva (if mouth be healthy) do not convey infection]. Discharges from primary sore (chancre) are most infective. The germ is also found in the substance of chancre, indurated glands, secondary eruption.

Diagnosed by (1) Wassermann reaction, which is not specific, whose presence does not necessarily indicate active syphilis and whose absence does not exclude syphilis. (2) Luetin Reaction which indicates anaphylaxis. A patient in whom the Wassermann reaction has become negative after energetic treatment will respond more readily to luetin reaction than before treatment.

Parasyphilis—refers to paralyses, tabes dorsalis and aortic sclerosis.

When Syphilitics can marry.—During the tertiary stage, without infecting the other partner, but, with full chance of having children with hereditary syphilis—unless and until one was permanently Wassermann-negative.

Control of syphilis (1) Educate the public as to risks and educate medical men as to the supreme importance of early diagnosis and treatment. (2) Prophylactic washing and use of calomel ointments. (3) Marriage of syphilitics should be controlled by the state. (4) Segregation, periodical compulsory examination and forcible admission of suffering prostitutes may be adopted.

Leprosy.

Etiology—Bacillus Leprae. It is found in the cells and lymphatic spaces of persons affected. **Incubation Period**—uncertain.

Types—tuberculous, anæsthetic.

Incidence—rare before 5 and after 40 years.

Spread : Fomitally ? Direct corporeally ?

Prevention : (1) Isolation with segregation of patients. (2) Remove new-born baby to separate places. (3) Observe cleanliness in cases of sores. (4) Disinfect fomites and burn nasal secretions, saliva, urine and milk of lepers.

Cholera Asiatica.

Distribution—in humid regions of the tropics, *e.g.*, Gangetic delta, northern Persia &c.

Etiology—comma bacillus. The power of anti-cholera serum to agglutinate the vibrio (Pfeiffer's test) is variable ; but in an epidemic, negative Pfeiffer's test should not be depended on. Moreover, soon after its excretion from the human body, the vibrio undergoes such rapid modification in water, milk, food, soil &c as to become almost unrecognizable—external influences tending to its destruction. Moreover, many cholera-like vibrios are found in waters during cholera epidemics and these should be suspiciously watched. Five to 8 days should not be considered as the limit of time of persistence of the vibrios, at any rate, during epidemics. The proportion of non-agglutinating cholera-like vibrios found in the ordinary stools of cholera carriers is inversely to the number of agglutinating ones, till both cease altogether with cessation of epidemic.

Incubation period : a few hours to 2 or even 10 days.

Types—Ambulatory, cholerine, cholera sicca, typhoid.

Diagnosis : Diarrhœa, dysentery, cholera nostras, mushroom or ptomaine poisoning, irritating poisoning.

Incidence—In tropical and humid weathers—attacks all persons at all ages.

Recurrence—one attack does not give immunity.

Spread—(1) *Aerially*—by dust laden with dry cholera stools or vomits. (2) *Fomitally*—by soiled rags. *Alimentally* viâ foul drinking water, milk and vegetables infected with fouled water. *Contact*—by flies.

Prevention of spread of Cholera. It includes measures for —(1) Personal protection. (2) Preventing spread in the same household. (3) General protection of the district and (4) Special protection. (1) GENERAL MEASURES *to be adopted in all cases:* (1) Compulsory and prompt notification by householders (2) Early isolation of patient in his own house or only in cholera hospitals. (3) Attendants and nurses and corpse-bearers * are to consider themselves under quarantine—to keep their nails cut short, to use antiseptics freely in their hand, to get themselves treated as soon as ever any symptom of diarrhœa sets in ; to avoid eating un- or over-ripe fruits or vegetables, to avoid unboiled milk and water†, to avoid eating rich, badly cooked or stale food ; to observe special care as to the cleanliness of their hands, food and eating and drinking vessels ; to undergo anti-cholera inoculation—for their own safety ; and for the safety of others, to avoid bathing or washing themselves or their dishes etc. in common tanks or wells ; to avoid mixing with others at table ; to keep their own set of drinking and eating utensils—each one for himself. (4) All vomits, stools, rags and other rejected stuffs are to be burnt—never thrown into the street. (6) Dead bodies are to be thoroughly cremated or buried at least six feet deep. (7) *Disinfect* (*a*) the room occupied—by white-washing the walls, by scrubbing the floor with Izal or other strong antiseptics and thoroughly airing it ; (*b*) the bedding to be burnt—or steamed thoroughly and then exposed them to the sun for some days successively ; (*c*) latrine—by scrubbing the seats with brush and strong antiseptics and the pans by antiseptics ; (*d*) drains and sewers—by free use of phenyle or slaked lime and water. (8) Never allow dung, refuse or any kind of dirt whatsoever to accumulate anywhere near.

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* In case of new arrivals of these to a different town or port or in their own places, these are to be treated as carriers; for, examination of their apparently normal stools has revealed in many, but not in all cases, the presence of vibrios. Hence the safe rule is to consider every one who carries a vibrio, whether agglutinating or not, as a carrier if he comes from an epidemic area.

† Simple filtration or treatment of water with pot. permanganate does not render water safe : it must be boiled. The use of unfiltered water to wash cooking and eating utensils or to rinse the mouth with—has given rise to cholera.

(B) *In Private families :* Notification, isolation, self-imposed quarantine of attendants, burning of dejecta and rags and disinfection, as above.

(C) *In Villages.* (1) Notification, isolation, self imposed quarantine of attendants. (2) Constant guard should be placed over water-supply (tank or well)—so that the same tank or well or the vicinity of either, may not be used for bathing, washing and drinking ; discourage dipping the feet into water, or of anybody and everybody's vessel into water for drawing it. If necessary, treat the well or tank with pot. permanganate. If it is a tap, wash it thoroughly with any strong antiseptic and let some water run to waste before using it. Washing the soiled clothes of a cholera case or bathing by contacts near wells or tanks is harmful ; for, the germs adhering to the clothes etc., may soak into the soil of kutcha houses or drains or into the soil and find their way therefrom into tho nearest well or tank. (3) Use the strictest supervision over food, milk and vegetable supply—specially enquiring as to the source of water used to dilute milk or wash the vegetables, and to cleanse the cans and other vessels. Insist on foodstuffs being kept in covered receptaclcs, so that dust and flies may not settle on them and promptly destroy unwholesome food. (5) Penalize rag picking and the indiscriminate throwing of rags into the street. (6) Prohibit the sale of food stuffs by inhabitants of affected village to inhabitants of other parts. (7) Appoint an army of qualified medical men, nurses and attendants with proper medicines and appliances and antiseptics. (8) Distribute educating leaflets in vernacular.

(D) *In places of Pilgrimage.*—Cholera is spread along the route of human progression ; a man taken ill can thus carry it hundreds of miles away and there create a new focus. When out pilgrimaging, to starvation and fatigue are added uncongenial meals taken at all sorts of irregular hours and in questionable states of preservation and purity ; any kind of water is greedily drunk on the way, regardless of its source and purity. And, in the case of Hindus, the '*prasad*' or divine offering, collected by the votary on the spot, and the *charanamrita* (or the divine feet-washings) consisting of a festering mass of milk, water, sandal paste, flowers and leaves and what not, with which the deity is bathed—are fruitful sources of cholera. In all places where thousands of people suddenly congregate for short periods, the following are recommended :—

(1) Have sufficient sanitary and nursing staff with a good supply of medicines. (2) Have regular (if necessary hourly) communication with the Railway or Steamer authorities and the sanitary authorities of the nearest villages—as

to the ingress and egress of pilgrims, and notices of fresh attacks and deaths. (3) Police the sources of water supply; where a river is used for bathing as well as drinking, no bathing should be allowed above the source of supply. (4) Erect huts, laid out in blocks, with suitable sanitary conveniences. (5) Sanitation should be looked after by an adequate and competent staff at least twice daily. (6) Latrine receptacles should be disinfected with chloride of lime and their contents burnt or buried two feet deep, well away from the camp, to the leeward side. (7) Insist on early notification and prompt isolation of patients. (8) Provide pure supply of food and drink and sanitary storage and handling of the same. Keep out flies (*a*) Erect locally disinfecfors and incinerators.

Dysentery.

Etiology : (1) *Bacillus coli communis*—in sporadic cases. The b. coli communis, b. proteus vulgaris &c. which ordinarily occur in large intestines of man, take on virulent action, when, owing to lowered vitality or uncongenial food, catarrhal irritation of the intestinal mucous membrane occurs. (2) *Entamoeba hystolytica* or E. dysenteriæ—in endemic, protozoal or amoebic dysentery. This is found in the stools (several in number and motile, in freshly passed motions), in the bases of dysenteric ulcers and contents of post dysenteric hepatic abscesses. It enters with food and thrives in the aklalinity of the intestines. It penetrates the mucous membrane here and has liquefying action on the tissues. (3) *Shiga-Kruse's bacillus dysenteriæ*—in bacillary or epidemic dysentery. This agglutinates with the blood serum of persons suffering from dysentery in dilutions of 1 in 10. It resembles b. typhosus but does not agglutinate in serum from typhoid cases. (4) A filter-passing micrococcus—found in blood, liver, spleen, kidneys and bile of sufferers from asylum dysentery.

Incubation period—a few hours to several days, according as the infection is through mouth or rectum.

Types—Catarrhal, ulcerative, gangrenous; acute, chronic.

Diagnose from—Colitis, intussusception, bilharzia hæmatobia, rectal cancer, irritant poisoning.

Spread—Aerially by flies, dust containing dried dysenteric stools, alimentally through drinking water, fomitally by infected instruments or latrine seats.

Check spread of Epidemics by (1) Isolation of patient in separate Dysentery wards. (2) Sterilize water and milk. (3) Forbid irritating articles of food. (4) Avoid chilling the body abdomen downwards. (5) Avoid diarrhœa, constipation, alcoholic excess, dirt and overcrowding and damp. (6) Cremate or bury dejecta after disinfecting them.

Plague, Pestis.

Distribution: (1) Endemic in Kumaon and Gharwal in India for a long time, now in Bombay, Mesopotamia, Hong Kong, Jeddah. (2) Epidemic in Egypt, Australia, Europe and several places in India. (3) Sporadic—at the close of an epidemic.

Etiology—Bacillus pestis of Kitasato and Yersin—found in the discharges from buboes, blood, spleen, foeces, urine and in sputum and foam of pneumonic cases. It flourishes in damp dark places; heat (62° – 65°C) and sunlight kill it. The bacillus found in rats loses its virulence when sub-cultured artificially; that in man retains its virulence for long periods during subculture and recovers full virulence if again passed through the animal body.

Incubation period: 3 hours to 15 days, usually 2 to 8 days.

Death usually within 48 hours. Those surviving 8 days seldom die.

Types : (1) Bubonic, Pneumonic, Septicæmic. (2) Pestis fulminans or siderans, P. major, P. minor, P. ambulans. [Now-a-days, *Pestis minor* means those mild cases of enlarged non-venereal glands which are seen just before and during a true outbreak of plague and in which the b. pestis cannot be demonstrated.]

Diagnose from : mumps, typhus, malignant malaria, pneumonia [Plague in the rat is almost always a septicæmic disease ; but, in man, the primary septicæmic form occurs much less often than the bubonic and any bubonic case may become septicæmic shortly before death]. Plague among rats is followed by plague among men.

Incidence—among dwellers in dark, damp, rat-infested rooms, among the coloured races and in warm weather—being checked by cold and by great dry heat. One attack confers immunity.

Spreads—(1) Aerially by germ-laden dust gaining access to mucous membranes of nose, mouth, pharynx, conjunctivæ &c. (2) Tellurically—by germs lying on the ground gaining access into the body through cracks and fissures on the lower extremity. (3) Corporeally—by urine and excreta and by inhaling the cough (∴ spray of sputum and froth) of pneumonic cases ; and from rat fleas or their excreta deposited on the rat's skin. It is propagated from rat to rat and from rats to human beings, via rat fleas. (4) Fomitally.

To arrest spread : (1) Notification compulsorily. (2) Isolation of cases in plague hospitals or in patient's house, if convenient. (3) Evacuation of infected houses.—if necessary of whole town. Quarantine and segregation for 10 days of mild or ambulant cases, suspects, contacts or persons coming from plague infected quarters. (4) Medical inspection of all new comers to a place. (5) House to house inspection to find out fresh attacks. (6) To prevent rats—do not store grains on the premises or let garbage accumulate in or near the house. Do not keep rubbish or lumbers heaped up. (7) Destruction of rats—by avoiding accumulation of refuse and dirt on the premises, by keeping cats and dogs, by trapping, asphyxiating, poisoning them or by feeding rats with Danysz bacillus, which gives an enteric-like disease to rats and which is not so easily catching to man. Corpses are to be wrapped in cloth soaked in strong perchloride and coffins packed with carbolized sawdust. (8) Destruction of infected rags, clothes and beddings—or their steam disinfection followed by exposure to sun. Before removal, they should be well sprayed with formalin. Nothing from patient should be discharged into W. C. until treated with antiseptics. (9) Opening up of dark ill-ventilated rooms and lanes. Disinfection of rooms by a soap emulsion of kerosene oil. If basement is kutcha concrete it ; if wall has holes and crevices, remove the plaster and replaster. (10) Advise prophylactic of Haffkine's vaccine 2 to 3 cc., to be repeated in 12 to 20 days and use Yersin's serum as curative. (11) Cremate rather than bury dead bodies after previous disinfection. (12) Remove defective drains. (13) Inspect granaries. (14) Those engaged in plague duty should wear boots, putties and gloves. (15) Educating literature should be distributed broadcast, free medical aid should be provided and efficient scavenging insisted on.

Rats and Plague.—(1) Plague affects rats before it attacks men. (2) *If dead rats are found*, never handle them ; pour sufficient kerosene oil over them and burn them on the spot to ashes ; if they cannot be burnt there, remove the kerosened carcass by a pair of tongs and subsequently burn both the tongs and the carcass. (3) The domestic *black rat* (mus rattus), not the brown field mouse, nor the bandicoot is carrier of plague, In the blood of rats, b. pestis can be demonstrated in large numbers during plague epidemics. The rat flea can retain the plague bacillus alive and virulent from 7 to 8 days. It shuns light. *The rat flea* (Pulex Cheopis) feeds on the blood of the rat and in its stomach, enormous number of b. pestis can be demonstrated. When the rat dies, the flea seeks the human host. By biting man in the neck, arms, legs etc. it can inoculate him with b. pestis or, the flea may deposit its b. pestis-laden excreta on human body; the excreta irritates the skin; the person scratches himself and thus inoculates himself with the bacilus. (4) *Diagnosis of Plague stricken Rat*: It moves heavily, its buboes are prominent and sometimes it suddenly dies. After death, carcass assumes wooden rigidity, feet (specially front ones) are pink (from hæmorrhage), buboes are found in decending order of occurrence,—on neck, axilla, groin, pelvis.

Ratflea

Malaria (Paludism, Ague).

Distribution: Endemic in West coast of Africa (between the mouths of the Niger and Congo), in Campagna (Italy), in Bengal, Madras and other places in India.

Etiology—the Plasmodium malariae—an intercorpuscular haemoparasite—that is carried from man to mosquito and mosquito to man. Persons living in malarious regions get gradually immune to attacks of parasites, from having suffered repeatedly from malaria when they were young; children therefore are better foci for spread of malaria than adults. Three factors are essential to a malarious attack: (1) A person suffering actually with malaria and having gametocytes in his blood; (2) female anopheline mosquito of certain genera; and (3) a susceptible individual bitten by such anopheline mosquitos harbouring sporozoites in their salivary glands. As soon as a parasite enters human blood, it does one of three things: (*a*) it may be killed by leucocytes; (*b*) it may remain dormant in some form in the spleen; or (*c*) it may at once proceed to develop and give rise to fever.

Incubation Period: 8 to 12 days after bite of mosquito, during which time, the collective toxins of innumerable parasites can upset human metabolism sufficiently to give him fever. But there may be a very prolonged and latent period.

Types (1) Quotidian (which may also be double tertian or triple quartan), Tertian, Quartan. This all depends on the time occupied by the cycle of schizogony; thus, Haemamoeba malariae—requires 72 hours, H. vivax, 48 hours, H. malariae 36 to 48 hours. Thus, clinically, there are two types of tertian fevers—benign (h. vivax) and malignant or sub-tertian (h. malariae). (2) Benign (tertian or quartan—which do not form crescents; and Malignant (quotidian or tertian)—which do form crescents. (3) Intermittent (one kind of infection), and Remittent (=mixed infection).

Incidence depends on the life history of the Anopheles and is therefore different for different countries. In Bengal, it commences with commencement of rainy season and ends with onset of cold weather. Dwellers in malarious places enjoy partial immunity. Recurrences are very common.

Diagonsis: (1) Find the *parasite* in blood. (2) Find *pigmented* leucocyte, usually the *large mononuclears* or hyaline leucocytes (evidence of recent infections). (3) Look for *increase of* relative proportions of *large mononuclears*, without any increase in the total number of leucocytes (evidence of past infection—found even after six months.

Spreads: (1) *Aerially*—in so far as air disseminates the flying mosquitos. (2) *Indirect corporeally*—from man to man sleeping under the same curtain, via mosquito. *Directly corporeally*—by intravenous injection of blood containing the parasite.

Malaria Prevention.

(A) MAKE A SURVEY OF THE ENDEMIC AREA BY—

(1) Correct *census* of the area. (2) The "*endemic index*"—*i.e.*, percentage of persons (*a*) carrying parasites in their blood and (*b*) carrying enlarged spleen— specially children under 15 years of age. (3) The average number of persons carrying the *gametocytes* in their blood. (4) Diagnosis of the *parasite* found in blood. (5) The *number* of anopheles in the area. (6) The *species* of the anopheles in the area. (7) The *species* of anopheles which *carry* the parasites. (8) The *species* of in which the *parasite is found in nature.* (9) *Breeding places* of the anophelines. Determine also the (*a*) *rainfall*, (*b*) natural *drainage* and outfall of the country, *(c)* state of *rivers* and *embankments* (if any)and *(d)* amount of *forest* near.

(B) PREVENT ORIGIN OF CASES : (I.) *Prevent breeding places of mosquitos by* these measures of securing water-tidiness of the place : (1) Drain pools and swamps—by engineering or by planting trees that absorb water freely as eucalyptus trees. (2) Fill up, oil or deepen—holes, ruts, burrowpits and prevent water accumulating in old broken jugs, pitcher, tin canisters &c. Repair stand-pipe leaks. (3) Screen wells, cisterns etc, with wire gauge. (4) Remove plants likely to collect water (*e.g.*, bamboo, pine apple, fibre plants etc.) and cover up hollows in rocks and holes in trees. (5) In tanks etc. —(*a*) remove moss and other vegetation, *(b)* cultivate in the water larvicide fishes like—the 'millions', techoko fish, &c., *(c)* cover the surface with petroleum (1 oz. per 15 sq. ft. of surface) once a month, or, what is better, introduce crude petroleum (20 drops per gallon of water) at the bottom of the water and stir it, *(d)* canalise them, *(e)* disinfect the water with aniline dyes, or *(f)* disinfect the water by vegetable germicide like unexpanded flowers of Dalmatian chrysanthemums. (6) House-hold waste water should be quickly and efficiently disposed of. (7) Drain swamps or fill them up. (8) Lower the ground-water level.

(II) *Destroy the Mosquito*—by hunting it out and killing it by means of adhesive surfaces, fumes of sulphur or pyrethrum.

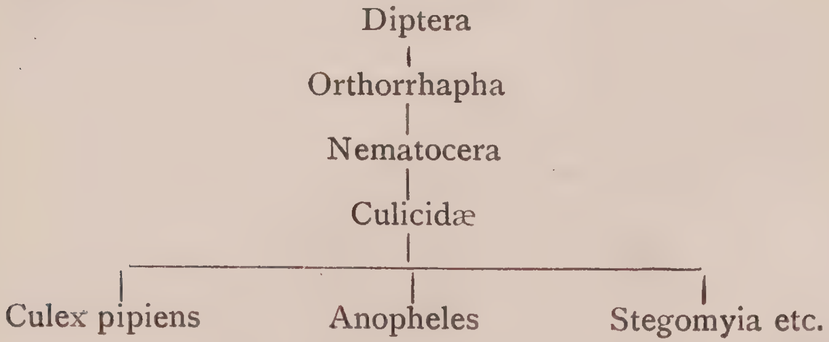
(III) *Protect yourself from mosquito bite* by—(1) Living in wirenetted mosquito-proof houses from sunrise to sunset. (2) Never have lights in rooms whose windows are not mosquito-proof. (3) Never stir out of doors after sunset; if you do so at all, cover yourself with clothes from head to foot, have gloves and anoint your face with an oil mixed with eucalyptus oil or menthol, or this mixture: citronella oil 1½, kerosene 1, cocoanut oil 2 parts with 1% carbolic acid. (4) Use mosquito curtains at night. (5) Prophylactic use of quinine (gr. 10 per week). (6) Avoid malarious places. (7) Do not live in the same room with a malarious case. (8) Prevent imigration of malarious patients. (9) Have no haunts for mosquito.

(C) PREVENT SPREAD. I. *By Isolating* the patient, so that he may not be the focus, from which to infect mosquitos and through mosquitos, human beings. II. Actively *treat sufferers* with large doses of quinine. Koch recommends—15 grs. on two consecutive days, every 8 or 10 days; Celli, 6 grs. daily; Plehn, 8 grs. every 4th day; for children, 1 gr. for every 3 years of age. III. *Those who are not suffering*,—*(a)* should avoid—chill, over-fatigue, too much exposure to sun, digestive disorders; *(b)* should be well-fed, housed in premises with concrete floor without holes and pits, with white washed walls, with no dark corners full of lumber and with fine netting all around it, and should use quinine; (*c*) should protect themselves from mosquito bite.

(D). *Other anti-mosquito methods* besides those given above: (*a*) Clear jungles, cut big trees and specially small ones, remove grass and grow crops on these sites. (*b*) Remove rice fields to a distance. (*c*) Have standing anti-mosquito brigades. (*d*) Educate the people. (*e*) Weeds and other obstructions to drains; grass, weeds, shelving edges, holes at margins of lakes and ponds; weeds and pools in made-water channels; bad levelling of kutcha drains; pits dug near wells to get earth for scouring utensils; all these should be removed. (*f*) All pits are to be filled or deepened; all hollows in rocks and holes in trees should be concreted. The habit of scraping the earth to scour utensils with, must be discouraged. Railway companies should be compelled to excavate earth so as to form regularly laid out deep tanks and not irregular puddles. (*g*) Stand pipe leaks or kutcha cwells should be penalized.

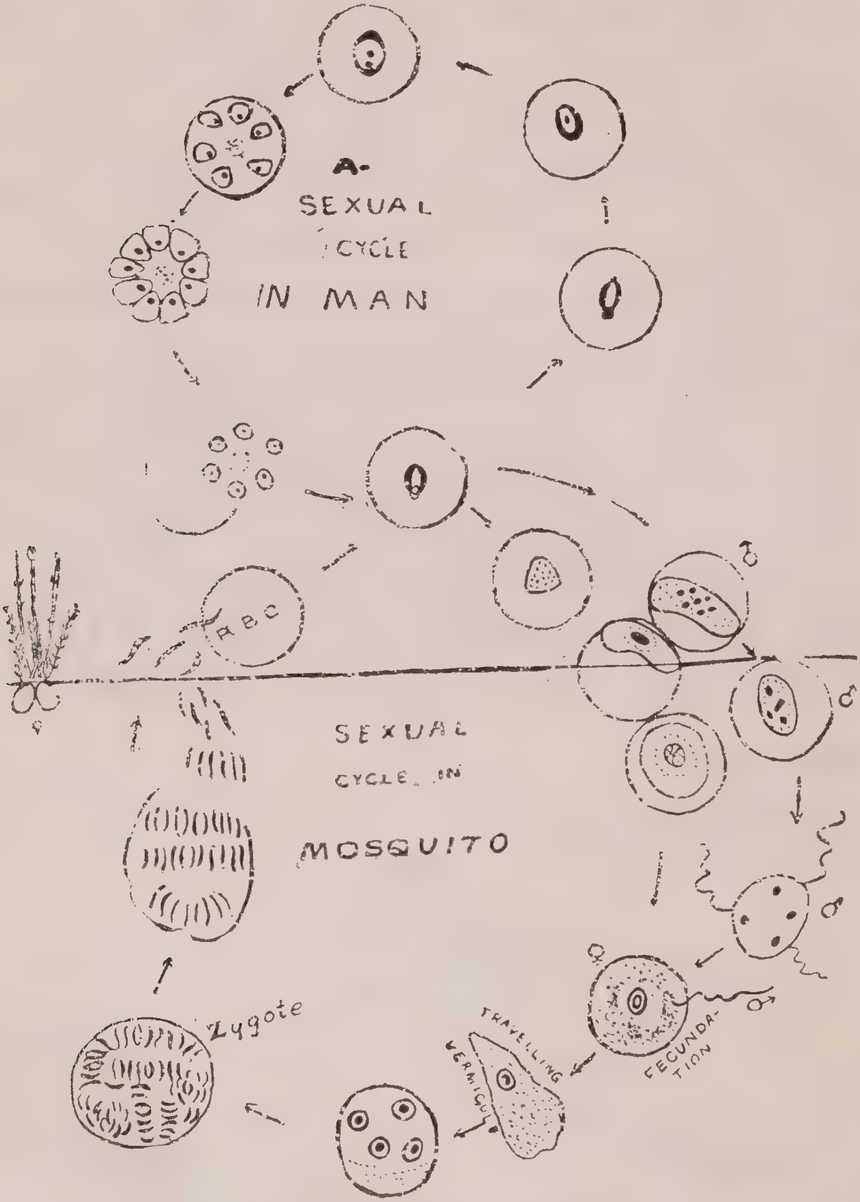
Mosquito.

CLASSIFICATION.



The anopheline group of mosquito is the carrier of malarial parasite; it is the definitive host of the parasite, man and some other vertebrates acting as intermediate hosts. The anopheline genus is not confined to malarious districts alone.

Out of nearly 120 known species, the VARIETIES OF ANOPHELINE mosquito common in Bengal are :—(1) Nyssorhynchus Fuliginosus (and var. Adiei).—This is the commonestanopheline but a rarecarrier of malaria. (2) Nyssomyzomyia Rossi (and var. Indefinata) are common in towns (as in Calcutta) but this and (3) Myzorhynchus Nigerrimus do not carry malaria. (4) Myzorhynchus Barbirostris, :(5) Neocellia Fowleri (6) *Myzomyia*



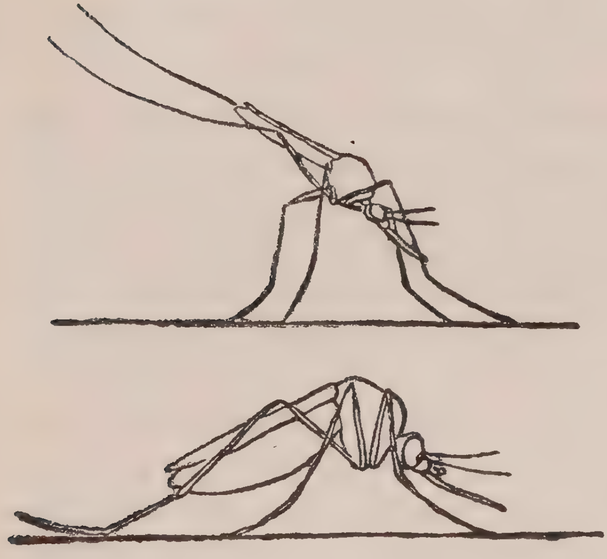
culicifaciens, M. listoni—both of which are found in running waters—and M. albirostris. Probably the Myzomyia group is the most responsible for carrying malaria.

ROLE OF THE MOSQUITO=To complete the sexual cycle of Parasite (=Sporogony or cycle of Ross) *What it receives*: When an anopheline female mosquito bites a human being, in whose blood male and female crescents are present, a large number of these sexual forms are sucked into the mosquito's stomach. The male anopheles does not bite man. *What take place inside Mosquito*: (*a*) In its stomach, the red corpuscle disintegrates, liberating the parasite. (*b*) The *female* sexual form (macrogametocyte) becomes a granular spherical body of reduced size with a minute papilla on its surface and is called now *macrogamete*. (*c*) The *male* form (microgametocyte) as soon as liberated from the corpuscle inside the mosquito's stomach, gets reduced in size and its pigment scattered, when 3 or 4 flagella (*microgametes*) are suddenly given off (polymitus stage); these flagella then break off and swim about in the fluid still in the mosquito's stomach. (*d*) One of these flagella (microgametes) meeting a macrogamete, enters the body of the female form, through the hole in the papilla and fertilizes it. (*e*) The fertilized female now becomes an ovoid with a pointed end and is called *Ookinete*; it becomes motile and penetrates the wall of the mosquito's stomach and lodges itself among its muscular fibres (*f*) Now it assumes a spherical form and is called *Oocyst* or *zygote*. The time occupied from the bite to formation of Zygote is 36 hours. By a system of division called sporogony, a vast number of spindle-shaped embryo parasites (*Sporozoites*) are formed in the full grown zygote. (*g*) After 6 days to 3 weeks (according to the temperature), the zygote's capsule bursts and the sporozoites are discharged into the midgut of the mosquito. (*h*) Thence the sporozoites travel up to the venosalivary glands by way of lymph stream. *How it is conveyed to man*: Now if such a mosquito bites a man, a large number of the sporozoites is conveyed at the point of the piercing stylets of its proboscis into human circulation. [This sexual cycle of development inside the definitive host, the mosquito occupies 10—12 days].

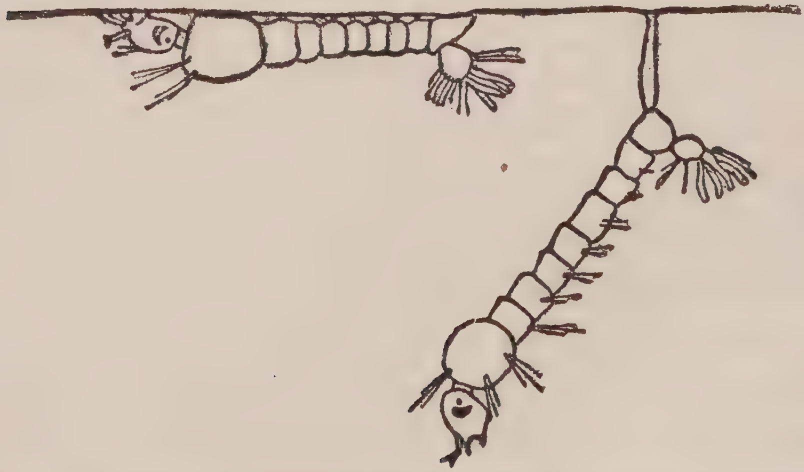
HABITS OF THE ANOPHELINE MOSQUITOS: They love (1) warm *climate* where natural collections of water abound; (2) dark *places* where there is not much of wind; (3) the *smell* of decaying vegetables and of leather and odoriferous skins—hence they love greasy, oily, dark skinned races and frequent places where boots are kept or used-clothes are hung to dry; (4) *sounds* of all kinds, specially if low and musical; (5) *colours* liked by them are (in descending order) dark blue, dark red, brown, red, black, grey and violet. Colours disliked (in same order) are: yellow, ochre, azure, white; (6) they seldom *travel* beyond half a mile of their haunt in search for food; seldom rising to high altitudes or flying against wind; (7) they *feed* exclusively at night or in the early morning. The male anopheles lives on succulent vegetable juices, the female anopheles on blood.

THEIR BREEDING. (*a*) Very soon after birth, a female mosquito gets its meal of blood early in the morning; then soon after, it becomes fertilized. The anopheline mosquitos lay their ova (*eggs*) 50 to 150 at a time in shallow collections of water on their leeward, unfrequented and vegetable overgrown aspects. Clean or foul, clear or turbid, acid, alkaline or ferruguinous does not matter; only it must be still and full of aquatic plants; each egg floats separately. (*b*) In the same water, the eggs burst in 2 or 3 days, liberating the *larval* mosquito which has a head, a thorax and an abdomen (without any legs), and a breathing aperture placed dorsally at the posterior half of the abdomen, without there being any caudal tube. That is why the anopheline larva floats horizontally beneath the surface of water. The larval stage varies with the food and temperature, being shorter in the tropics (12 to 21 days).

(*c*) The *pupa*, or nymph stage lasts 48 hours. Pupæ do not eat. (*d*) *Imago* or adult mosquito is hatched out towards afternoon, very soon after which, the female gets fertilized. The full fledged mosquito lives a month.



Anopheles and culex.



Upper one is Anopheles, the lower one culex larva

DIAGNOSTIC PECULIARITIES of (1) the Anopheles Imago or adult : (*a*) The *palpi* are club-shaped or cleavate ; and in the male are as long as, or longer than, the proboscis ; in the female, scaled and as long as the proboscis. (*b*) *Wings* have spotted appearance. (*c*) *Attitude when sitting* :—The entire body projects as a straight line (not hump backed) so as to form a distinct angle with the wall—not parallel with it. (*d*) It is nocturnal in its habits, flies without making much noise and bites without inflicting much pain.

[In the case of culex mosquitos, which are common, but do not transmit malaria, (*a*) the palpi in the male are the same length as the proboscis but are shorter in the female ; (*b*) their young hang with head downwards in water, at right angles to the surface].

ENEMIES OF ANOPHELES LARVAE : Water beetles, water animals, duck weed (lemna) and small fish, specially (*a*) Haplochilus panchax (*techoko*, *panchoke*, *lal jhingra*), (*b*) Haplochilus *Lineocolatus* (*piku*), (*c*) Trichogaster fasciatus (*Kazara*, *khajura*, *khalsia*), (*d*) Badis badis (*Bhedo*, *chiri*), (*e*) Anabas scandens (*koi*), (*f*) Chela Agentea (*chela*, *chilcwa*) and sulphurous, sea and saline waters are inimical to larvæ.

ENEMIES OF MOSQUITOS : (1) *Hot weather* when breeding places disappear and mosquitos and their eggs die from heat and dryness. (2) *Heavy rain* which suffocate the larvæ and kill the females laying eggs. (3) *Spiders* specially the plexippus paykulli (family salticidæ). (4) *High winds.*

The malarial Parasite. It is not a plasmodium. Its CLASSIFICATION is this : *Class*—Sporozoa, *family*—hæmamœbidæ, *genus I.*—hæmamoeba characterized by the mature gametocytes being similar in form to the mature sporocytes before the spores have been differentiated, *species*—(*a*) hæmamoeba vivax vel Laverani = parasite of benign tertian fever, which lives in the circulating blood and develops in the spleen ; (*b*) h. malariæ = parasite of quartan fever—which lives and sporulates in the circulating blood. The toxins of these, therefore, produce general symptoms. *Genus II*—Hæmomenas, in which the gametocytes have a special crescentic form ; *species*—haemomenas præcox (vel Laverania malariæ) ; *Varieties*—Aestivo-autumnal or malignant parasites (tertian, nonpigmented quotidian, pigmented quotidian) (?) This so profoundly alters red cells as to cause them to adhere to the walls of the capillaries of the organs in which the parasite sporulates—thus producing several local symptoms. ITS HOSTS: The parasites have never been found in the water or air of marshes, nor in decaying vegetation, nor in the soil. They pass and repass alternately between (1) certain species of different genera of *Anopheline mosquito* and (2) *Man* (or other vertebrates). MORPHOLOGY—The *Sporozoites* consist of cytoplasm containing a central nucleus, composed of chromatin. Their ends are pointed, one being sharp; they are capable of movement forwards. INSIDE MAN. There are two cycles that a malarial parasite may go through—Golgi's cycle (schizogony) and Parthenogenesis in man and sporogony (sexual cycle) in mosquito.

I. SCHIZOGONY:—(1) When bitten by mosquito, the sporozoite enters a corpuscle and becomes an endo-corpuscular parasite when it is called *trophozoite*. It is then composed of cytoplasm and a nucleus. (2) It* throws out pseudopodia and gets a vacuole—both for purposes of absorbing nutriment. The parasite is now ring-form. (3) The trophozoite outgrows the vacuole (∴ is no longer ring form), ceases amoeboid movements, collects pigment (hæmozoin) granules, becomes globular form, and is now called *schizont* (which is indifferent sexually). (4) The nucleus now divides into 2, 3, 4, 5, 6 upto 24 nuclei. The cytoplasm around these nuclei divides into small bodies (*merozoites*) around a central undivided mass of cytoplasm, containing hæmozoin. The parasite is now rosette-form (5) The blood corpuscles rupture, liberating into the blood—pigment, toxins (?), residual protoplasm and merozoites, some of which are quickly engulfed by leucocytes. The surviving merozoites enter new red blood cells and go through the same cycle of a-sexual schizogony. **Or,**

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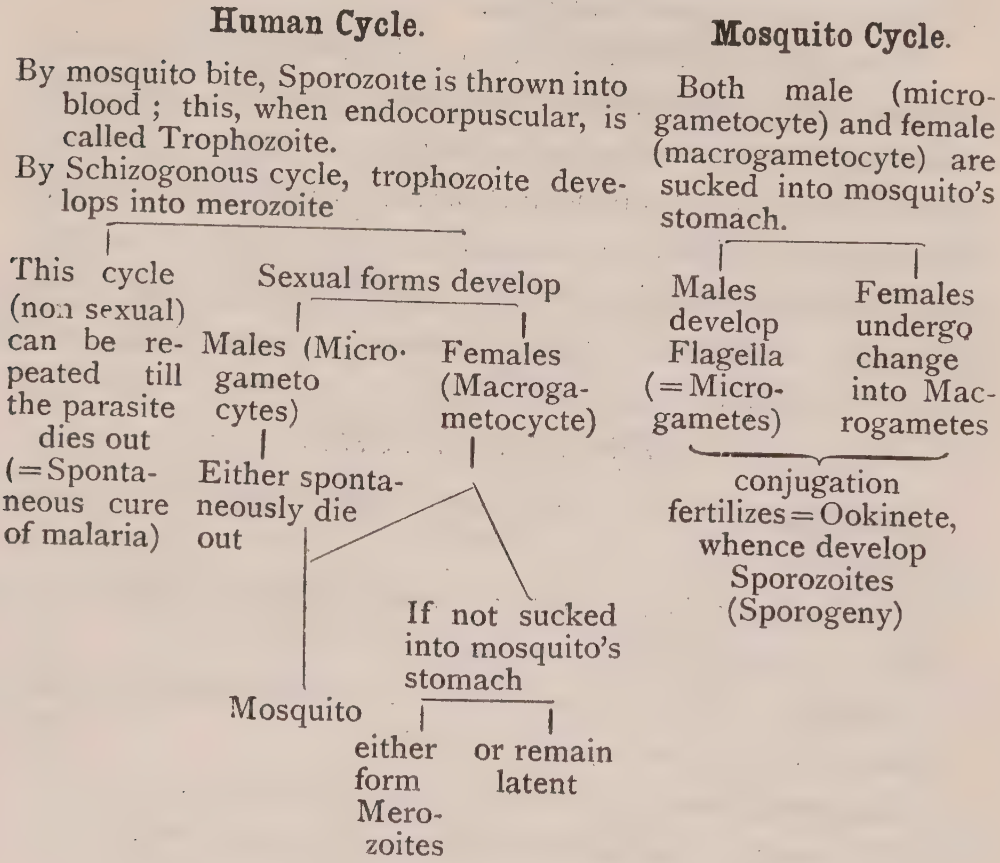
* Usually one merozoite enters a red cell; but more than one may—in which case, multiple infection, but no flagellation or conjugation, of the merozoites occurs, at least in man.

In about a week from the development of merozoites, we find sexual forms of the parasite in the blood—(*a*) *Macrogametocyte* (female)—which is poor in chromatin but rich in granules and pigments and has an ec-centrally situated, rounded nucleus; (*b*) *Microgametocyte* (male)—which is rich in chromatin but poor in granules and pigment and has a large band-like nucleus extending across the cytoplasm. Now one of three things may happen:—(*a*) If a mosquito sucks such blood, the sexual cycle of development (described before) occurs inside the mosquito. Or,—(*b*) If no mosquito bites such a man, (*i*) the microgametocyte dies off; (*ii*) the macrogametocyte either (α) waits in the human body for years (latent period), till a favourable opportunity revivifies it and the victim gets a recrudescence of his malaria; or (β) develops parthenogenetically —when its nucleus divides into two portions, one rich and the other poor in chromatin. Pigment granules gather round the latter, when the former divides like the nucleus of a schizont and forms fresh merozoites, which, in their turn, begin life anew. [Parthenogenesis = production of a number of small parasites from a fully mature female parasite which has not been fertilized by the male element].

Graphic chart of Plasmodium Life-history.



Human Cycle.

By mosquito bite, Sporozoite is thrown into blood ; this, when endocorpuscular, is called Trophozoite.

By Schizogonous cycle, trophozoite develops into merozoite

- This cycle (non sexual) can be repeated till the parasite dies out (=Spontaneous cure of malaria)
- Sexual forms develop
  - Males (Microgameto cytes)
    - Either spontaneously die out
  - Females (Macrogametocycte)
    - If not sucked into mosquito's stomach
      - either form Merozoites
      - or remain latent
  - Mosquito

Mosquito Cycle.

Both male (microgametocyte) and female (macrogametocyte) are sucked into mosquito's stomach.

- Males develop Flagella (=Microgametes)
- Females undergo change into Macrogametes

conjugation fertilizes = Ookinete, whence develop Sporozoites (Sporogeny)

Yellow Fever.

Distribution—along sea coast and river deltas in Africa and America.

Etiology—an ultra-microscopic organism, conveyed by bite of mosquito. The germ is transferred to the mosquito, during the first 3 or 4 days of the disease ; mosquito retains it for at least 57 days and can infect man 14 days after having sucked it from a patient's blood.

Incubation period : a few hours to 30 days—usually, 2 to 6 days. **Types**: Mild, severe, grave ; apoplectic, algid, choleraic.

Incidence : Specially common among male adults in the rainy season ; white races are most susceptible, yellow ones less and black ones still less. One attack confers immunity.

Spreads (1) Aerially—by the presence of moulds. (2) By Stegomyia fasciata mosquito.

Prevent by (1) Notification. (2) Isolation (3 to 4 weeks) of sufferers in places where the disease is not endemic. (3) Quarantine (10 days) of contacts and suspects. (4) Evacuation of affected area. (5) Ships with sufferers should land patients and steer for colder latitudes. (6) Ventilation. (7) Disinfection and thorough removal of moulds. (8) Discard ground-floors, as in cases of plague. (9) Anti-mosquito operations, as in cases of malaria.

Black-water Fever.

Synonyms :—Bilious remittent fever, malarial haemoglobinuric fever.

Distribution : Africa, certain places in India (Dooars, Terai, Assam, Madras, Canara District, Jaypur etc.)

Etiology : Malaria (?) + Quinine Sulphate administration ?) + chronic alcoholism, syphilis etc. (?)

Diagnosed from ; yellow fever, acute yellow-atrophy of liver, Weil's disease. **Prevention**.—Avoid quinine *sulphate.*

Kala Azar.

Synonyms : Tropical febrile splenomegaly, Dum Dum fever, malarial cachexia.

Distribution : Assam, Madras, Burma, Indo-China, China, Ceylon, Arabia, Sudan, Egypt.

Etiology : Leishman-Donovan bodies. These bodies may be found in the spleen of those suffering from Kala Azar and Tropical Ulcer, Delhi boil, Aleppo button, Oriental sore.

Spread by—bed bugs. **Prevent**—by stopping direct human intercourse.

Sleeping Sickness, (Tripanosomiasis in man).

Distribution—central and western Africa.

Etiology : Trypanosome Ugandiense or Gambiense (Dutton).

Spread by—the biting fly, glossina palpalis.

Life history of the parasite : They have three forms—male (delicate), female (resistant to adverse circumstances) and indifferent. All these may multiply by fission—this power being in abeyance in the males and females. Under certain circumstances, the female can be self-fertilized ; but then it reverts to the indifferent type. Maturation occurring in a vertebrate host is abortive ; in the invertebrate host, conjugation occurs and a zygote forms. In vertebrates (man, dog, pigs etc.) the immature forms are found ; thence they are transferred to the body of glossina palpalis (invertebrate host) : when it bites suffering man, dog, pig etc. Inside the glossina's body, sexual development occurs, in which state, the trypanosomes are transferred to man, pig or dog by the bite of the glossina.

Prevent by (1) Clearing jungles—so as to open out to sun's rays the margin of water courses and swamps. (2) Draining and filling swamps. (3) Forbidding the breeding of pigs and dogs. Dogs and pigs are to be rigidly kept confined in wire-gauzed pens all day, being allowed liberty at night. They were to be periodically examined for trypanosomes and those found with it were to be slaughtered or treated vigorously. (4) Providing such dress for inhabitants as will not leave any part of the body uncovered. (5) Catching and destroying the glossina.

INVESTIGATION OF AN EPIDEMIC.—Proceed as follows :

I. Ascertain General Informations in respect of : (1) *The District* : Its geology, altitude, relations to water, its temperature, level of ground water, rainfall, special prevalence of any animal or insect known to carry disease. (2) *The Dwellers* : the number of fixed and floating populations, milk supply, water-supply, meat supply, refuse-removal-arrangement, means of transport, intercourse with the sick or with neighbours, state of dwellings. Have there occurred extensive excavations or dredgings ?

II. **Particularly enquire about** :—(1) Patient's *duration of living* in the present address and his recent migrations accurately. (2) Escape of *sewer gas*, escape of coal gas, extent of overcrowding (room by room), position of bed-room and kitchen with reference to W. C. (3) *Occupation* of sufferers, the exact addresses where they worked recently. (4) Recent occupation of his dwelling by a previous sufferer or convalescent.

III. **Try to fix the place where the first case occurred** and then the various *foci* (bazars, public conveyances, wells, dairy etc.) of spread.

IV. Are certain **ages, occupations or sexes** attacked ? Are certain **districts** with special sanitary, geological or meteorological defects attacked ? Are certain **houses** with common food or drink supply attacked ?

V. **Bacteriologically examine**—dejecta, soil, water, milk, food, clothes, cooking or serving vessels, and the oral cavities of suspects (carriers).

TRANSMISSION OF INFECTIOUS DISEASES :

I. *Disease*	*Transmitting host*
Plague	Rat flea from rat and rodents
Malaria	Anopheles mosquito
Pellagra	Sand fly ? (Simulium Reptans ?)
Yellow fever	Stegomyia Fasciata.
Dengue	Culex
Filaria	,,
Relapsing fever & kala azar	Bed bug
Sleeping sickness	Glossina Palpalis (Tsetse fly)
Three-day fever	Plebotomus papatasi
Tuberculosis	Cow
Rabies	Rabid dogs
Sheep-pox	Sheep
Anthrax	Cattle
Glanders and Farcy	Horse
Actinomycosis	Cattle.
Mediterranean Malta Fever	Goat

II. Methods of Infection.

Water ... Transmits enteric (?), dysentery, diarrhœa, cholera.

Food ... Transmits enteric, dysentery, diarrhoea, cholera, tuberculosis, ergotism, beri beri pellagra and Malta fever, leprosy, food poisoning.

Soil ... Transmits enteric, cholera, diphtheria, diarrhœa, tuberculosis, ankylostoma.

Sandfly—transmits pellagra, three-day fever.

Bed bugs—Kala azar, relapsing fever.

Culex—Dengue, filaria

Anopheles—Malaria

Cats, Pigeons, Fowls, Snipe—Diphtheria.

Rat—Plague, Trichiniasis.

Infected clothes—Cholera, plague, diphtheria, measles, scarlet fever, small pox, influenza enteric.

CHAPTER XXIX.

PARASITES OF MAN.

Definition. A '*parasite*' is a creature nourished entirely or in part at the expense of another living organism. *Saprophytes* are organisms that obtain their nourishment from the dead remains of organisms.

Degree of Parasitism.—(1) Parasite and host may live without mutual injury or parasite may end up by destroying its host. (2) Parasite may live throughout its existence in the host; or it may wander from animal to animal. (3) Some are parasite in their early life but free in their mature state. (4) Some live inside the body of host (endoparasite), others on the body surface (ectoparasite).

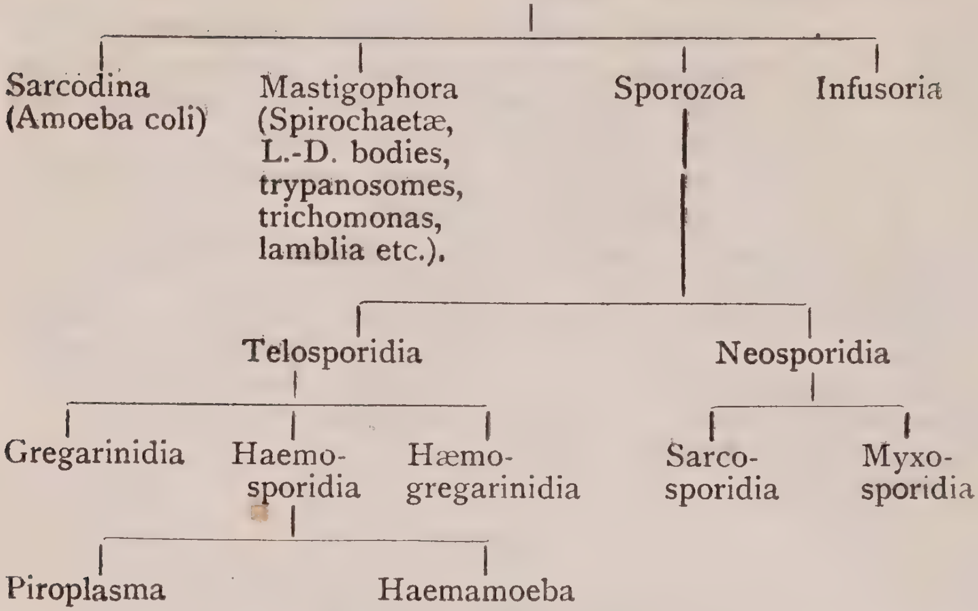
Classification :

I. BLASTOMYCETES OR YEASTS.—Oidium albicans which is a torula and is the cause of thrush.

II. HYPHOMYCETES OR MOULDS :

1. Achorion Schonleini—causes favus
2. Trichophyton tonsurans— „ ringworm
3. Microsporon furfur— „ pityriasis versicolour
4. Streptothrix Maduræ— „ Madura foot

III. PROTOZOA



Amoeba Dysenteriæ.—*Appearances*: Round or oblongish, with an outer pale membrane enclosing a greenish, highly refractile mass containing vacuoles and a nucleus. *Movements*—of whole mass and of pseudopodia constantly occurs.

Trichomonas vaginalis inhabits vagina
„ intestinales—occurs in some diarrhœas
Lamblia Intestinalis

Trypanosoma—*possess* a longitudinal undulating membrane which terminates anteriorly in a free flagellum. They *occur in* fish, amphibia, reptiles, birds and mammals. They have a *second host* (a blood sucking invertebrate) in which the sexual cycle occurs (See p. 452). *T. Evansi*—the parasite of surra (in horses) conveyed by probably a horse fly. *T. Brucei*—the parasite of "ngana" or tsetse-fly disease. It cannot be inoculated in man. *T. Gambiense* vel *Ugandiense* (*Dutton*) is the parasite of sleeping sickness, conveyed from dogs, pigs etc. to man by the biting fly glossina palpalis.

Spirochætæ—are wavy or spirally twisted, with an undulating membrane but no flagella. S. Obermeieri—causes Relapsing fever. S. Duttoni—causes Tick fever in man. S. Pallida—causes (?) Syphilis. S. Pertenuis—causes Yaws.

Leishmania—is a suborder of the flagellated protozoa. They are most often intracellular, being found in leucocytes and cells of endothelial nature. They are not piroplasma, nor degenerate trypanosomes, nor spores of microsporidian. *Stages of development* : (1) Enlargement of the macro-nucleus, without any corresponding change in the micro-nucleus. (2) Appearance of the eosin body : it is a rounded body to which the micro-nucleus is closely attached and from which the flagellum arises. (3) Appearance of flegella (rarely before the third day). (4) Division of early flagellated forms—micronucleus and flagellum divides into two and then macronucleus divides. (5) Formation of rosette. (6) Elongation and separation of individual forms which become free. *L. Donovani*—causes Kala Azar. *L. Tropica*—causes Oriental Sore.

Plasmodium Malariæ : *P. Malariæ*—causes quartan ague. *P. Vivax*—causes benign tertian ague. *P. Immaculatum*—causes malignant tertian or tropical ague. Each of these has gametes, young ring stage and large forms. Their differentiation is this :—

	Benign Tertian	*Quartan*	*Malignant Tertian.*
Size of mature Parasite	Larger than average RBC	Smaller than average RBC	½ of average RBC.
Number of spores	18 to 24 ...	6 to 10 ...	6 to 30.
Amœboid movement	Active and extensive	Sluggish ...	Active but not extensive.
Gametocytes ...	Rounded ...	Rounded ...	Crescent.
Effect on RBC	Pale and swollen Schufner's dots in stained specimens	Small and dark	Young parasites yellow (brassy) ; old ones decolorize the RBC.
Pigment ...	Finely divided and brown	Coarse and black	Black ; at first finely divided, soon clumping.

Cytoryctes = intracellular parasites of small-pox and vaccinia. (?)

IV. PLATYHELMINTHES.

[(*a*) Turbellaria (*b*) Trematodes (*c*) Cestodes].

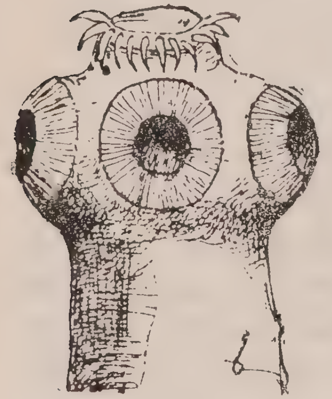
These are symmetrical worms with a flat body. Most of them are hermaphrodites—reproduction being sexual, only occasionally occurring by budding or segmenting.

Fasciola hepatica (liver fluke). *Found in*—gall bladder or duct of man, sheep and other ruminants. *Size* : ½ to ¾ inch. *Intermediate host*—fresh water snail. [cp. Distomum sinense found in Chinese and Japanese]. *Diseases produced* : hæmoptysis.

Distomum Ringeri : *Habitat*—Lungs of Japanese and people of Corea. *Intermediate host*—mollusc or fresh water animal.

Bilharzia Hæmatobia : *Habitat*—Portal vein and its ramifications in men of Africa (Egypt, Cape, Natal), being ingested with drinking water. *Forms* : A male with cylindrical body and a female, both of which possess two suckers (one oral and the other ventral). *Diseases produced*—hæmaturea. *Life history* : Adult worm is found in portal system of man. Eggs (with spine) and ciliated embryo pass out with foeces and urine respectively. The embryo enters the body of a crustacean, where it becomes encysted, the encysted larva being transferred with the crustacean in drinking water to the human stomach, whence it passes via intestinal walls, to the portal vein.

Taenia saginata, Beef tape-worm : *Habitat*—small intestines. *Length*—over 26 feet. *Longivity*—many years and for 14 days after death of host. *Characteristics* : (1) Head has no hooklets or rostellum but has four pigmented suckers. (2) Is composed of 1000 to 1300 segments—each segment containing both male and female organs. Complete development of the germ-producing organs occurs at about the 600th segment, while the embryo may attain maturity at about the 1000th segment. *Life history* : Mature worm is found in man ; eggs are expelled with his foeces on grass. The ox takes this grass (∴ the eggs too) into the stomach, the embryo passes to the muscles of the ox, where it remains as a bladder worm, (cysticercus bovis). Eating this flesh raw or badly cooked, transfers the cysticercus into man's alimentary canal, where it develops into sexually complete adult. *Term of infection* in man—is 9 to 12 weeks after ingestion of the cysticercus.



Taenia Solium = Pork Tape worm. *Habitat*—Small intestines. *Length*: over 11 feet. *Characteristics*: Head (about a pin's size) is round, with prominent suckers; the apex bears a medium sized rostellum with 28 hooks. (2) Made up of 850 segments and the sexual organs are fully developed at about the 400th segment. *Life history*—Same as in T. Saginata; the intermediate host is preferably the pig—but man himself can be intermediate host too.

Echinoccus Hominis:—"Hydatid". This is the cysticercus stage of *Tænia Echinococcus*, a tape worm infesting the wolf, jackal and dog. THE ADULT WORM: *Length* = $\frac{1}{5}$th inch. *Characteristics:* Body is made up of 3 or 4 segments, of which the last is the biggest. This contains 500 eggs. Head—has a crown surrounding the bulging rostellum, on which are 28 to 50 hooks arranged in two series. *Life history:* The adult worm lives inside dog, wolf or jackal. With their foeces, these animals pass the eggs on to vegetables, straw or into water. The vegetables are eaten or the water is drunk by man, ox, pig &c. From stomach, the embryo burrows into various organs and specially into the liver, where it assumes the larval stage of a cysticercus. CYSTICERCUS STAGE: "Unlike other cysticerci, this bladder worm increases indefinitely in size and also forms within itself "secondary cysts", some of which, the so-called "brood-capsules", contain one or more echinococci ("scolices") and remain minute, while others, containing no scolex, enlarge and form other or "daughter cysts" which again may produce new cysts by a process of budding." Each scolex represents as many tape worms. *Term of infection*:—Mature worms are found in the seventh week of feeding.

Bothriocephalus Latus.—*Length:* 27 ft. *Characteristics:* Head is ovoid, without hooklets but has two longitudinal grooves or suckers. Is made up of 3500 segments. *Life history.*—The eggs contain an embryo, which is a ciliated organism with six hooks and can swim about in the water for a week. It then enters into the body of the pike or turbot whence it is ingested by man.

NEMATODES.

Oxyuris Vermicularis, Thread Worm. Male is ¼ iuch and female, ½ inch long. They are viviparous. *Habitat:*—caecum and upper part of colon. *Life history:* Eggs are passed by man with his foeces and deposited on vegetables or water. The eggs develop in water, moist earth or in the open. Ingesting this water or vegetables on which eggs lie deposited, as well as biting nails after scratching rectum during sleep, conveys the eggs into human stomach. The gastric juice bursts the eggs and the larvae pass to and grow in the upper intestines, where, in a month, they attain sexual maturity.

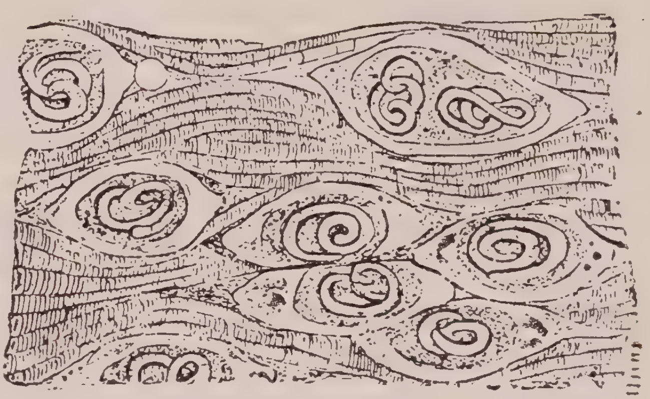
Filaria medinensis, Guinea Worm. *Found in*: Arabla, Brazil, Demerera, India, Egypt, West coast of Africa, Persia etc. *Length of mature female*:—1 to 12 feet. *Characteristics*: It is milky white and cylindrical, the whole length of the worm being filled with embry-filled oterus. The embryos are extruded per oram. The male is rarely met with. *Habitat*:—beneath the surface of the body. *Life history*: Embryo is extruded by the mature female from under the skin of man or other animal, into waters. It swims about in water, where it enters the body of its intermediary host, the cyclops, in whose body in 5 weeks it develops considerably. When this cyclops is swallowed by man or other animals in drinking water, it bores its way into his tissues and inside him develops into fully mature sexual forms in 9 to 12 months. Where the sexes come together or what becomes of the male are unknown.

Filariasis.—*Distribution*: India, Burma, Ceylon, Indo-China, China, Japan, Arabia. *Etiology*—A transparent nematode worm, 3 to 4 inches long, called Filaria Bancrofti and a high temperature associated with considerable atmospheric humidity.

Types of Disease : (1) Lymphangitis (or. elephantoid fever)—with an erysepelatous inflammation of the skin. (2) Orchitis and hydrocele. (3) Lymphangiectasis (Lymph Scrotum). (4) Varicose lymphatic glands. (5) Chylous extravasations (hæmochyluria, chylous diarrhœa, chylocele, chylous ascites). (6) Elephantiasis or Cochin leg, Barbadoes leg. *Spreads* from man to man by these mosquitos :—culex fatigans, mansonia uniformis, M. pseudotitillans, pyretophorus costalis, myzomia rossii, myzorhynchus nigerrimus, m. minutus, stegomyia fasciata. *Prevention* by : Measures similar to anti-malaria. LIFE CYCLE OF THE FILARIA : *In Mosquito* (Development Stage). When a microfilaria is sucked into mosquito-stomach, its sheath bursts, liberating the microfilaria. They then pierce the walls of the stomach and pass into the muscles of its thorax, where they grow in size, develop 4 lips, an alimentary canal and a three lobed tail ; when so developed, they pass through the prothorax and head into the labium—ready to be thrown into human circulation. *In Man* (Undeveloped stage = Microfilaria.) The male and female lie coiled together in the lymphatics—males being numerically less. The female contains ova inside her uterus in all stages of development ; when sufficiently developed (*microfilaria*), they escape through the genital pore into the lymph-stream. Thence they migrate successively into lymphatic vessels and glands, thoracic duct, right side of heart and lungs, into finally the general circulation, where they are best seen during man's sleep hours at-night—from 5 to 7 p.m. till-midnight ; after midnight, they decrease in number, being invisible in the peripheral blood in day time, when man is awake (hence called microfilaria nocturna). During day, they live in the lungs and vessels of the thorax and filariæ can live for years. The microfilaria cannot develop inside man.

Trichocephalus dispar, Whip Worm. *Distribution* : Tropics. *Habitat*—Cæcum. *Life history* : Eggs are discharged with foeces into moist medium or water, where they develop. Drinking this water causes liberation of the embryo inside the alimentary canal, where it fixes itself.

Trichina Spiralis, Flesh worm. Eating insufficiently cooked swine's flesh causes this disease. The immature trichina live encysted in muscles of mus decumanus (sewer rat), pigs, martens, dogs, bears, cats, foxes. When flesh containing the encysted trichina is eaten, the capsule is dissolved, the young worm is liberated; it develops in $2\frac{1}{2}$ days and breeds—and in 8 or 9 days is found in the muscles. See p. 205.



Ankylostoma Duodenale. *Distribution*: Lower Bengal, Assam, Egypt, Zanziber, Gold Coast, West Indies, Brazil, Peru, Java, Bolivia, Australia, Europe. *Disease produced*: Ankylostomiasis—a severe form of anæmia. *Habitat*: Villi of jejunum and ileum. *Length*: $\frac{1}{3}$ to $\frac{1}{2}$ inch. *Characteristics*: Both male and female are cyllndrical and have 4 strong claw like teeth in their mouths. LIFE HISTORY: Eggs are passed out with human foeces and deposited on moist soil, where high temperature and wind help to develop the embryo. The eggs are hatched in 4 to 8 days and in 3 to 4 weeks, the larva becomes encapsuled and can live up to 6 months in this state. If the encapsuled or fully developed larvæ are swallowed by man, or if the larvæ get into the human skin (as in miners, brick layers, agriculturists etc), then in about a month's time, their ova appear in the foeces of the host. *Prevention*: Wash hands before meals, keep nails cut short, drink only boiled water, stop indiscriminate defœcation.

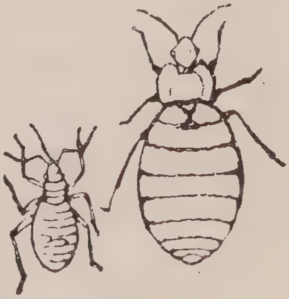
Ascaris Lumbricoides, Round Worm. *Length*: Males 6 inches, females 12 inches. *Habitat*——small intestines. LIFE HISTORY: Eggs are passed with foeces of man, pigs, rat etc., in which (foeces) the eggs develop. Passing into water, they are swallowed by man, inside whose body they develop.

ARTHROPODA.

Acarina or **Ticks.**—They are blood-sucking insects. LIFE HISTORY: The female deposits masses of eggs on grass or coarse herbage and dies. In 8 to 22 weeks, six legged larvæ grow, and crawl up grasses or plants, waiting to become attached to some host. Once thus attached, it sucks blood and drops to the ground and then moults and develops into 8 legged pupa. This pupa does the same things and, in 3 months' time, becomes an adult tick, which seeks a host, sucks blood and repeats the cycle. It is a blood sucker in larval, pupal and adult stages.

Acarus Scabei, Itch insect. The female of it penetrates the skin and burrows beneath the cuticle, laying her eggs at the far end of the burrow, where they hatch and the young insects in their turn, burrow in fresh directions.

Pediculus Capitis, head louse. They attach to the hairs near roots, occasionally burrowing into the epidermis. In about seven days a female lays fifty eggs.



Bed-bug

Cimex Rotundatus—the Indian bed bug. It is the carrier of kala azar.

Fleas.—The males are usually smaller. *Pulex irritans*—the common human flea. *Pulex Cheopis*—the common rat-flea which carries plague see p. 439. *Sarcopsylla penetrans*, the jigger or chigoe of West Indies, tropical America, Algeria, Soudan, Zanziber. It is common in sandy soils near sea coast. Both male and female suck blood of any host, to whom or which they can become fixed. When impregnated, the female bores her way into the skin of foot, leg, thigh, scrotum or other parts of the body. The egg is hatched, the larval and pupal stage is passed subcutaneously, in 8 or 10 days, a perfect insect emerging out.

Mosquitos or **Culicidae.**—Their *life history* (See p. 443).—They pass through the egg, the larva, and the nymph stages in water and the imago or perfectly developed stage in air. *Their pathological role* : The anophelinae convey the malarial parasite from man to man ; the culicinae, filaria ; and the stegomyia, the microorganism of yellow fever.

Muscinae or flies. *Musca domestica*, the common house ffy is the carrier of cholera, enteric and other bacilli. *Pycnosoma marginale* and *P. chloropyga* are Indian filth ffies.

Stomoxys : These are blood sucking flies. *Glossina palpalis*—transmits sleeping sickness ; and *g. morsitans*—transmits the trypanosome of ngana.

CHAPTER XXX.

DISINFECTION.

Definitions—A **disinfectant** is a substance that can prevent the *spread* of infectious diseases, by destroying their specific germs. An **antiseptic** is a substance that, by arresting the power of *propagation* of microorganisms, restrains or prevents decomposition. A **deodorant** is a substance that corrects or destroys offensive odours and gives a false sense of security to its user, inasmuch as it does not kill any germs but simply masks the offensive *odours.*

Necessity for their use :—Microbes and their spores being the cause of infection, it is to our interest to kill them wherever they are found in large numbers, e. g., on **human body** in septic or purulent parts ; on the person of **nurses, doctors,** sweepers etc who come in daily contact with patients ; in the **clothes,** beddings, discharges and **excreta** of the sick ; on the **floor,** or walls, furniture, hangings etc. of the sick room, etc. But the chemicals used are so strong that complete disinfection is a matter of time and strength—both of the patient and of the chemical used.

Classification and means.—The **natural** means of effecting disinfection are : (a) action of sunlight, specially of the ultra violet rays and (b) perflation of wind. The **artificial** means are—(a) **Physical**, as by application of heat (dry and moist) and exposure to air and (b) **chemical.**

Action of Air.—Air acts by (a) blowing away the germs, (b) oxidising them and (c) drying them. Air as a disinfecting agent is of poor value.

Action of Sunlight.—The sun has actinic or chemical rays and heat rays. Heat rays we consider below under heat generally. The chemical rays (the **ultra-violet** ones rather than the infra-red ones) restrain the growth of germs and are therefore feeble disinfectants. In the tropics, where the sun shines for a *long-time*, the *air* is freely moving and *moisture* is present, prolonged exposure to sun's rays helps to render substances germ-free.

Action of Heat—**Disadvantages of heat generally** are five in number : (*a*) *Scorching*—The maximum temperature that different kinds of fabrics can stand, before getting scorched, is 230° F. (*b*) *Overdrying*—which renders substances brittle. (*c*) *Fixing of stains of an albuminous nature*—*e.g.*, those of blood or excreta. If care is taken beforehand to wash out the stains in soap and cold water, fixing during heating may be obviated. (*d*) *Melting fusible substances*—like glue or wax (in books, leathern stuffs). (*e*) *Loss of finish*—*e.g.*, alteration of colour or gloss, shrinkage etc. **Disadvantages of "Dry" heat** : [Hot dry air was the former method of disinfection]. (1) Owing to dry heat *scorching* substances quicker, the amount of heat and the duration of it cannot be made sufficient. (2) The *penetrating* power of dry heat is slow ; hence, bulky articles (pillow, mattress, folded cloths) cannot be efficiently disinfected. (3) Owing to *unequal distribution* of it, dry heat is not an efficient germicide. [Its *advantage :* Leathern and rubber goods and bound books are not spoiled by it]. **Disadvantages of Moist heat :**—(1) It is a *very slowly* acting disinfectant. (2) It damages shrinkable articles (wool, flannel etc).

Emyloyment of Dry heat : (1) By BURNING. Things o small intrinsic value like huts, beddings, clothes etc., dead bodies aud dejecta of patients, should always be burnt. The burning should be done in the destruction furnace of the disinfection station and in no case be allowed to be done on public streets, whence unburnt particles fly about to neighbouring houses or sources of water supply. (2) BY RANSOM'S APPARATUS—which consists of a rectangular chamber of wood and iron, lined with non-conducting material. A constant current of air, heated by gas-jets upto 255° F., is kept up for 2 to 8 hours, according to the bulkiness of the articles. A large number of microorganisms, specially those free from spores, is destroyed by dry heat at 220° F in an hour. Note that even after 8 hours, a temperature of 212° F is not obtained beneath 12 layers of blanket, even though hot air at 235° F be passed in. No temperature short of 290° F for an hour is absolutely safe for dry disinfection.

Employment of Moist heat : [Remember that (*a*) THE KILLING HEAT for bacteria and the spores of some bacilli is steam at 212' F. for 5 minutes or hot air at 250° F. for 4 hours. (*b*) A SPORE may undergo any amount of drying without being killed ; the drier the spore, the less rapidly will moisture penetrate its membrane and dilute its albumen. For disinfection by heat to be effective, therefore, the maximum heat that fabrics can stand should be maintained throughout the period of exposure and enough of moisture should be present along with the heat] Moist heat in the form of **Steam** (free from air) is used in four ways : (*a*) as *current* passed over ; or (*b*) *confined* within a place ; (*c*) as *superheated* or dry steam ; or (*d*) as *saturated* steam. Steam generated at a temperature exceeding 100° C. under increased pressure is called saturated ; steam whose temperature is raised without raising the pressure, is superheated. Current steam is wasteful ; saturated steam is rapid and thorough ; superheated steam is less economical (as requiring longer exposure) and liable to injure the articles. Steam is generated by **stoves** and these latter are of three kinds : (*a*) Stoves without pressure—in which the temperature does not exceed 100°C. (*b*) Stoves with low pressure (2, 3 or 5 lb per sq. in.)—in which the temperature does not exceed 110° C. (*c*) Stoves with high pressure (10 lb or more)—in which a temperature upto 120°C. (or more) can be got.

Moist heat can be **utilised** in three ways : (1) *By boiling for 5 to 20 minutes* articles like clothes, linen, beds etc. The previous washing of these with soap and cold water and the addition of washing soda during the boiling add to the efficiency of the boiling. (2) By *high pressure steam disinfectors.* (*e. g.* Equifex stove, Goddard and Massey's, Thresh's or Reek's or Washington-Lyons).—In these, superheated or air-free saturated steam at 225° F. is kept confined in an air-tight chamber containing the articles to be disinfected, for 15 to 30 minutes. The temperature should not exceed 120° C. and the higher the pressure of the steam, the less is the time required for disinfection. (3) *By low pressure* steam disinfectors (*e. g.*, Reek's or Thresh's)—in which current steam is used.

Disinfecting station—should comprise :—(1) *Two rooms with a wall between*—into which *the stove* is built. Both rooms should be well lighted and ventilated and their walls made of smooth, non-porous material. The rooms and the men in each room, should never communicate with each other. Infected articles are placed into the stove from one room and removed from the other. (2) *An Incinerator* (with a small second fire)—to destroy destructible articles, including the products of their imperfect combustion. (3) *Van Rooms*—separately for infected and disinfected articles. (4) *Laundry.* [Articles brought from infected areas must be put inside moistened canvas bags and these sealed bags may be put directly into the disinfector. The person handling infected goods must put on an overall which must be disinfected when done with.]

(A) LIQUID CHEMICAL DISINFECTANTS.

Essentials of a Disinfectant are : Its action must be permanent, be complete within 30 minutes, it must be non-poisonous, readily soluble in water, cheap, non-injurious to utensils and articles exposed to its action and not possessing offensive odours.

Rideal-Walker Standard.—To measure the efficiency of various disinfectants, Rideal and Walker suggest the following standard :—*Carbolic acid* is taken as the standard disinfectant and *bacillus typhosus* as the standard germ. At 15° to 18° C., to 5 cc. of any given dilution (in sterilized water) of a disinfectant, add 5 drops of a 24-hour blood-heat culture of b. typhosus in broth (of a reaction of+15). Every 2½ minutes take sub-cultures upto 15 minutes and incubate them for 48 hours at 38°C. Then by dividing the dilution of the disinfectant that does the same work as the standard carbolic acid solution, by the standard carbolic acid solution, we get what is called the Carbolic Acid Co-efficient. [Some now-a-davs use the *bacillus coli communis* as the standard germ instead of b. typhosus.]

[**Martin-Chick** (Lister Institute) **standard** :—B. typhosus is the standard germ, the medication occurs at 20° C, the test organism is added to an emulsion of 3% human foeces dried at 102° C and sterilized at 120° C and an interval of 15 minutes is allowed for the disinfectant to act on the test organism. The result is expressed as above as phenol coefficient.

Their requirements : Only those chemicals (1) that can destroy the life and power of development of micro-organisms without being virulent poisons to man ; (2) that are swift and sure in their action ; (3) that do not become inert in the presence of organic pollution ; (4) that produce no injurious effects on the human tissues or articles of daily human use ; and (5) that are cheap ;—only these are the best. But unfortunately they are very few. Chemical disinfectants to be effective must be used in association with water ; solids therefore must be dissolved and gases mixed with moisture. Chemicals act—by either oxidising or reducing the germs or by coagulating their protoplasm or by acting as direct poison.

As a rule, liquid disinfectants gain in efficiency, if (*a*) they are used in the form of an *emulsion* (hence, izal is more powerful than carbolic acid) ; (*b*) when *hot* water is used in dissolving them and (*c*) only *soft* and *pure* waters are used in dissolving them. The presence of albuminous matter (foeces &c.) tends to diminish their usefulness.

Hydrarg. Perchlor.—used in the *strength* of 1 : 1000 (8.75 gr. to Oj). *Action* : kills non-spore-bearing bacteria in 15 to 30 minutes and a strength of 1 in. 500 kills spore-bearing bacteria. *Disadvantages* : (1) It corrodes metals and is destroyed by contact with them. (2) It coagulates albumin and therefore is precipitated on the surface of tissues, and in contact with soiled linen, being rendered inert and unable to penetrate deeper. [This is lessened by adding to it a little acid hydrochlor. diluted] (3) It is poisonous and therefore has to be kept coloured by adding 1 grain anilin blue to a gallon. (4) It is not a safe disinfectant for linens. *Solubility* : Readily in alcohol and ether and sparingly in ordinary water. The addition of a little sodium chloride or of acid hydrochlor. dil. or of ammonium chloride increases its solubity in water.

Mercuric Iodide.—*Strength* : 1 in 1000 for washing hands and instruments and 1 in 4000 for floors. *Advantages* (compared with perchloride) : Less poisonous ; does not corrode metals so rapidly; does not precipitate albumen to the same extent. *Solubility*: In water nil. But the addition of a little pot. iodide increases its solubility.

Carbolic Acid or Phenol.—*Strength*: 5% or 1 in 20 for resistant organisms and for soaking dressings and 1 in. 40 for disinfecting hands. *Solubility*—great in water. *Disadvantages*: It is a poison, has a caustic action and coagulates albumin. *Advantage*: It is feebly deodorizer.

Cresylic Acid products: (*Varieties:* Cooke's cofectant liquid, cyllin (1:500), izal (1:200), Jeyes' fluid, kerol, Lawes' fluid, lysol, Mac Dougal's M. O. H. fluid, sanitas-bactox, sanitas-okol saprol &c). *Composition:* phenols, neutral oils, resins (sometimes gelatine), fatty acids, water. *Strength used*—1 in 200 for non-spore-bearing organisms and 10% for spores. *Advantages:* Practically non-poisonous, cheap, easily soluble and slightly more efficient than carbolic acid. [Izal is specially germicidal to the coli-typhoid group.]

Phenyle—is cheap but not a very efficient disinfectant.

Formic Aldehyde. *Strength*: a solution of 1 to 2% ["Formalin"=40% solution]. *Advantages:* cheap, rapid deodorant and disinfectant.

Chinosol. *Solubility*—great. *Advantages:* Non-poisonous, non-corrosive, strongly deodorant and does not coagulate albumin. *Strength*: 1 in 1000 is equal in disinfecting power to perchloride of mercury.

Chloride of Lime (Bleaching Powders). *Preparation:* To a thick solution of calcium chloride add hypochlorite of calcium solution, so as to possess a *strength* of—35% of available chlorine. For general use,—1·5% solution (=2¼ oz to 1 gallon); for resistant organisms, 1 in 1000. *Principle of action:* In the presence of moisture and acids, HCl and O are liberated. *Ad-*

vantages: cheap, strong deodorizer. *Disadvantages*: corrodes metals, action is rapidly exhausted on organic matter (foeces etc.)—often leaving bacteria unaffected.

Sodium Hypochlorite. *Strength required*: At least 0·5% available chlorine. ["Chloros" contains 10%]. *Advantage*: Absence of lime. *Disadvantages*: Apt to lose strength on keeping.

Lime—freshly burnt, if used as wash is a fairly reliable disinfectant for walls.

Hypochlorous Acid. *Preparations*: That prepared by Hermite process from sea water is weak and unstable; that prepared by electrolysing a solution of magnesium and sodium chlorides—is more stable.

Acids (Mineral)—are fair antiseptics, if used in markedly acid strengths.

Copper Sulphate.—*Strength*: 5%. *Action*: coagulates albumin, poisons bacteria, absorbs ammonia, the compound ammonias, sulphuretted hydrogen etc.

Zinc Chloride.—*Strength*: 10% solution (with a little hydrochloric acid) for spores; 5% for non-spore-bearing bacteria. ["Burnett's fluid" = 50%]. *Disadvantages*: solutions over 5% are corrosive. It is a very weak disinfectant.

Ferrous Sulphate or **Ferric Chloride**: *Strength*: 20 to 30%. *Disadvantages*: Feeble disinfectant, stains articles, forms moulds of iron. *Advantages*: Absorbs ammonia and H_2S, and is ∴ a deodorizer.

Pot. Permanganate or **Condy's Fluid**: *Strength*: 5% solution. *Disadvantages*: Stains articles, expensive at 5% strength, and is powerless against germs in the presence of organic matter. ["Condy's Red Fluid" = Pot. permanganate + sod. sulph.]

"Sanitas Fluid".—*Strength*: 10% in water. *Advantages:* Non-poisonous. *Disadvantages:* Powerless against spore bearing germs.

(B) GASEOUS DISINFECTANTS.

Formic Aldehyde. *Suitable for*—surface, like those of rooms, passages, corridors, stair-cases &c. *Advantages*: very efficient, rapid, does not affect colours or metals (except iron or steel). *Disadvantages:* Very irritating to eyes and throat; affects iron and steel, fixes stains of blood and foeces. *Procedure for its use*:—As it is likely to froth over, remove floor-carpet. A temperature of 70° F. and humidity of 70% are necessary to its efficacy. Seal up the room in every way and keep it so for six hours. Wear goggles. Use one of these: (*a*) Trillat's apparatus at 40 ℔ pressure, for ½ hour, utilizing ½ to 1 litre of formo-chlorol; or 25 "Paraform tablets" for every 1000 cft. of space; (*b*) Autan's method:—for every 1000 cft. of space, use ½ pint formalin (40 %) or 100 crushed "Paraform tablets" and 5 oz pot. permanganate crystals—using heat if tablets are used. Remove all traces of formic aldehyde by fumes of ammonia.

Sulphur Fumigation.—*Action*: the SO_2 gas evolved, in the presence of moisture acts as an antiseptic. *Disadvantages*: It diffuses badly, has bleaching action, acts on bronze, gilt and copper and is irrespirable; hence, to open sealed rooms, wear a wet towel moistened with washing soda over the mouth. *Advantages*: cheap, destroys vermins. *Procedure*: use 3℔s sulphur for 1000 cft. of space. Take two or more shallow basins full of hot water and over them ignite sulphur candles or small bits of rolled sulphur treated with a little spirit on a metal tray; or an ordinary benzoline lamp filled with carbon disulphide may be lighted or two cylinders (each of 20 oz) of liquified sulphur may be emptied into a room 1000 cft. The room must be kept sealed for 6 and 24 hours and thoroughly aerated subsequently.

Chlorine *Disadvantages* : Expensive, strongly irritant, heavy (∴ slowly diffusible), injurious to silk and to metals, requires the presence of moisture and day light. *Advantages* : Powerful disinfectant (even in 1°/₀) and deodorant, combining with ammonia and sulphuretted hydrogen. *Procedure* : Place as high in the sealed room as possible, in several vessels, a total quantity of 2℔ bleaching powder and 1℔ hydrochloric acid (commercial) for every 1000 c. ft. (=35°/₀ available Chlorine).

Bromine. *Disadvantages* : more irritating, destructive and expensive than chlorine. Use "Liquid Bromine" in the presence of moisture.

Iodine is not used, as expensive, heavy and staining articles.

Nitrous Acid. *Advantages* : It is constantly active and does not destroy organic colouring matters. *Disadvantages* : Very irritating and disinfecting power is weak. *Procedure* : For 1000 cft. of space, mix 3 oz. nitric acid, 3 oz. water and 1 oz. copper shavings.

Hydrochloric Acid fumes : Its marked acidity is germicidal.

Carbolic Acid Fumes : *Disadvantages :* Large quantity is necessary (1 pint for 1000 cft. space) and its odour is persistent. *Procedure* : Insert a red hot iron rod into a metallic bottle filled with phenol.

(C) SOLID DISINFECTANTS.

Carbolic Powders—*i.e.*, carbolic acid with lime (which soon becomes inert , or with silicious matter or absorbent woodfibre or peat—all of which lose 1 to 2°/₀ carbolic acid by keeping.

Slaked Lime **Bleaching Powder**	Are caustic, attack metals, absorb H_2S and organic vapours.

These are not to be poured into drains.

[**Sanitas** + **lime** forms a good deodorant].

Charcoal—when freshly prepared and dry absorb bad odours, and oxidise them—vegetable charcoal absorbing better than animal charcoal.

Soap—is a weak disinfectant.

Disinfection of certain articles :

Beds.—Stains should be first removed by soap and cold water; then boiled for 20 minutes with a little washing soda. **Books**—Sea Leather. **Corpses :** Cover them by sheet soaked in any one of these : izal (2%), carbolic acid 5%), perchloride of mercury (1:500), formic aldehyde (1%) and they should be cremated. **Dress**—See Linen. **Furs**.—See Leather. **Gilt Surfaces** : wipe with 1% carbolic. **Gulleys**—disinfect with good carbolic powder or equal parts of 'sanitas' and lime. **Hands :** use rubber gloves ; or adopt successively these : scrub with soap and hot water, aided by a good nail brush ; scrub and soak in absolute alcohol for 5 minutes ; steep for 5 minutes in an alcoholic solution of bin-iodide of mercury (1:500). **Huts**—if of small value and infected with plague, should be burnt. **Leather goods**—disinfect by hot air ; or, by fumigation by 3% formic aldehyde vapours, in a sealed room for 4 hours. **Lice**.—Expose them and their eggs to steam at 100°C for ten minutes or to boiling water for 5 minutes. **Linen.** —See Beds. **Mattresses**—should be saturated with kerosene and burnt in a destructor—never in open streets. Or, they may be treated with steam under pressure. **Metals** : *Bronze*—wipe with 1% carbolic or immerse in a 20% hot solution of washing soda or soak in 1% solution of formalin for two hours. Copper—wipe with 1% carbolic. **Pillows**—See mattresses. **Privies** : use 2 oz of perchloride of mercury for each seat, twice a day. **Rags**

(soaked with excreta or discharges) should be burnt before they become dry. **Rooms** (bereft of contents, its wall-papers removed, walls scraped and ceiling lime-washed). It can be disinfected in three ways :—(1) *By spraying liquid disinfectants* on every inch of space. The Equifex sprayer or the Lumley Invicta spray with perchloride of mercury, formic aldehyde, chinsool, sodium hypochloride—used for 2½ hours for 1000 sq. ft. of wall space will be efficient. (2) *By washing and rubbing.* The walls and floor are scrubbed with old loaf of coir and then disinfectant is applied with swab or brush, with vertical and horizontal strokes. (3) *By gaseous disinfection*—by formic aldehyde, sulphur &c. [While patient continues to occupy room, (*a*) hang sheets moistened with disinfectants outside the door and (*b*) damp sweep the room with some antiseptic ; for, it has been found that coughing, sneezing and even speaking scatter infected material to a distance of 4ft. from the patient.] **Rubber goods.**—See leather. **Rugs**—Disinfect with steam. **Sputum**—may be cremated or mixed with plenty of saw-dust and kerosene and burnt. **Ships :** Disinfect by burning 1℔ sulphur for every 250 cft. space, in the Clayton gas apparatus —the gas delivering 15 °/₀ sulphurous acid together with some sulphuric acid. In two hours it kills all vermins but it is destructive to cargo and is too weak for pathogenic bacteria. **Stool**—Solid stools must be broken up with a stick. They may also be disinfected under steam-pressure or by boiling with strong solutions of Izal etc. They may be mixed with sawdust or chopped straw and kerosene and ignited ; or mixed with coaldust and ashes and incinerated. **Urine.**—See sputum. **Upholstered articles**—steam disinfected. **Utensils**—See Metals. **Vermins** : (1) In the house, remove all wooden skirtings, mouldings, wall paper etc., or size or varnish them. Sulphur fumigate the room, expose all iron and steel articles to a plumber's blow-lamp or brush them over with a spirituous solution of perchloride of mercury and dust dry, powdered lime into every crack and crevice. (2) Beddings and clothing are to be steam-disinfected (3) Verminous individuals are to have regular baths. **Wells.**—See p. 98.

Care of the Sick-Room.—Disinfect or cleanse every sick-room at the termination of the illness. If the room and its furnishings have been selected with foresight, the removal of all danger of contagion is a simple matter. The floor and walls of the room should be bare, and no curtains should be used except washable ones. *The room selected* for the patient should be as remote as possible from the other used portions of the house—a room at the end of a hall or off in an "L" is suitable ; rooms opening off through open archways into other rooms are not appropriate. The patient often is able to wait on himself, especially during the latter part of the convalescence. As a rule, a trained nurse is required and a bath-room adjacent. *The well members* of the family should not use the bath-room adjacent to the sick-room. But where there is only one bath-room, the seat of the toilet should be washed with an antiseptic solution after being used. The tub should be reserved either for the sick or for the well. All who enter the bath-room should regard it as neutral territory and should carefully avoid touching anything with the fingers. During isolation, food can be carried on a tray. After meals, the tray can be placed by the nurse in a dishpan left for the purpose outside, near the door. The dishpan can then be filled with water and set on the stove ; and after the water boils, the utensils may be handled safely.

The sick-room should be *cleansed* with a mop wrung out of antiseptic solution. The furniture, door-knobs, window-sill, and the accessible portions of the woodwork should be rubbed with a rag moistened with an antiseptic solution. *The bed-linen* should be removed with the minimum amount of waving through the air, and, together with the personal linen, should be placed into a clean pillow-slip. The laundryman or wash-woman should be instructed to soak the pillow-slip in boiling water for five minutes before removing its contents.

At time of discharge.—The patient's clean clothing should be placed *outside* the sick-room. The patient should then take a careful sponge-bath with a corrosive-sublimate solution. The hair should be thoroughly soaked in this solution. The entire body should then be rinsed off in pure water. The patient, leaving the sick-room without touching anything, should put on clean clothing, then go where he will. *The attendant* should take a bichloride-solution bath as described for the patient. This can be done either just before mixing the chemicals and starting the fumigation, or it may be done outside the sick-room and the clothing placed in a clean pillow, case to remain unhandled till boiled.

Disinfection of a Sick Room. The *floors* should be mopped thoroughly with corrosive-sublimate solution. The *mattress* should be wiped with a rag wrung out of this same solution. The *blankets* should be hung on lines or on the bed, so that they hang free of folds and wrinkles. The *closet-door* should be opened and the dresser-drawers pulled out, and all articles of *clothing* hung up on lines. *Furniture and woodwork* should be gone over with a cloth wrung out of the bichloride solution. *Books* should be disinfected in a small airtight box, by means of a concentrated vapor. Before starting the fumigation, the room should be made as nearly as possible air tight. Wetted strips of newspaper 6 inches wide will adhere over the *cracks* around the windows and doors. *Chimneys* can be stopped by stuffing in newspapers. *Keyholes* can be stopped with cotton.

How to suppress Fly, Mosquito &c.

Fly.—Begin in cold weather, when the flies are only a few. AVOID—all accumulations of rubbish, garbage and manure. Put them in covered bins or treat them first with crude petroleum, then with lime and finally with dry earth to a depth of 8″ inches. Formaldehyde solution (1 in 500) attracts flies and kills them. Fly papers, tapes or reels (made with bird lime, treacle and any poison) attracts flies. All food should be kept well covered ; so too dust bins, night soil receptacles, cess pools. Night soils must be deodorized, sinks and cess pools efficiently emptied and deodorized.

Vermins : (1) *White ants* :—dust calomel 1 part with sugar 10 parts. (2) *Black ants* :—dust powdered borax. (3) *Bed bugs* :—Fumigate with sulphur ; where cockroaches are, no crickets and bugs are found. (4) *Cockroaches* :—dust Izal powder. (5) *Mosquitos* : Fill pools and ditches, use kerosene, pesterine, salt or cyllin to kill larvæ. (6) *Fleas* :—use pesterine, (7) *Lice* on the body—killed by Jey'es fluid or oil terpentine mixed with equal part of oil lavender or ungt. hydrarg. If on the head, pour methylated spirit. (8) *Moths*—are killed by camphor and naphthalin.

Rats : Their *natural enemies* : owl, cat, weasel, common kestrel, ferret, mongoose, lizards. *Scents which rats avoid* : ol. eucalyptus, carbon bisulphide, turpentine, xylol, pesterine, kerosene oil, red coal tar. *Scents which attract rats* : Meat ; anisi, cocoanut, anethi, cajuput and poppy oils ; cantharidine and French brandy, tr. assafoetida, rancid fat, crude oil and bread.

CHAPTER XXXI.

VITAL STATISTICS.

Importance.—No medical officer of health can properly judge of the sanitation of his charge nor definitely recommend improvements, unless he compares notes with other places or countries. For purposes of comparison, statistics are necessary. Such statistics relate to the population, births, deaths, marriages, diseases, longivity and social and mental conditions—in respect of any particular country, district, borough or town.

They are called vital statistics because they relate to health. As a rule, the health of a community may be fairly judged from a study of these three : (*a*) the total *corrected* death-rate, (*b*) the *zymotic* death rate, and (*c*) the *infant* mortality ; but these four too are important to know : (*a*) *Phthisis* death rate, (*b*) mean *age* at death, (*c*) probable *duration of life* and (*d*) *Expectation* of life.

But, as the laws, customs and practices of inhabitants of different parts of this world differ, the compilation of such statistics is difficult, specially so in India. We consider below the important items of vital statistics, viz., population, birth and death—sickness being not well tabulated and marriage statistics being not very accurate.

Population.—An accurate statement of population forms the basis of all vital statistics. A fairly correct estimate of the population is a paramount necessity for purposes of comparison. (I) The **census** taken every tenth year does it. But it is superfluous to point out that all the census figures are not correct, owing to wilful misstatement or ignorance. Then, again, the census being taken on 31st March of every tenth year (the last one having been in 1911) deductions for intermediate months and years will have to be made. Generally speaking, a population does not remain stationary; in most instances, it increases. And it has been found that increase of population occurs in the inter-censal period *not* in arithmetical, but in geometrical progression. The annual increase is not constant, but is larger each successive year. Thus—if in 1901, the population was 35,626 and in 1911, 38,754 ; what would be the population in June 1916 ? If we deduct from 38754 the population 35626 and divide the figure by 10 years, we get 312·8 as the rate of annual increase of population. Now, between March 1911 and June 1916 there are 5 years and 3 months=5·25 years. By multiplying 312·8 by 5·25 wet get 1642,—to be added to the population for 1911, to give us the necessary result, 40396. But this arithmetical progression is fallacious. Hence, the population (P) at the end of a certain number of years (x) will be denoted correctly by the rate (r) of increase:—

$$P(1+r)^x$$

Hence, by using logarithm tables we find log 38754 = 4·5883165 and log 35626 = 4·5517671. Now, (4·5883165 — 4·5517671) ÷ 10 = 0·0036545 as the logarithm of the annual increase; and 5¼ × (0·0036545) = 4·6075026. And from the tables we find this figure gives a population of 40504—an increase over the former figure by 108.

It should be clearly understood that increase or decrease of population is never so uniform as simple mathematical calculations like the above would have us believe; in practical life, subsequent census figures have completely falsified our estimates—specially in reference to small communities, whose rate of growth is erratic.

The Registrar—General of England uses the following formula:—

$$\text{Log } p_2 = \log p_1 + n \frac{\log p_1 - \log p}{10}$$

where, p_2 = required population, p_1 = population of last census, p, population of census previous to that, n = number of years.

(II) As population is liable to increase or decrease in consequence of immigration or emigration, the Registrar General suggests that the **number of houses** inhabited be accurately ascertained from the assessment books of the year; then multiplying this number by the number of inhabitants per house (as given in the last census) gives a fairly accurate idea of the population.

III. Population can also be estimated from **birth rates,**— by the help of the formula:—(Number of births in the year × 1000 ÷ (Birth rate per 1000 in last census year).

(IV) Strict **record of emigrations and immigrations** with complete registration of births and deaths—will furnish a correct estimate of population. Increase of population is said to be *natural* when it refers to excess of births over deaths ; it is *actual* when it is dependent upon the balance between birth and immigration or death and emigration.

Birth Rate.—Though registration of births is compulsory, in some places, there are reasons to believe that it is not invariably done. Besides this difficulty, there is the list of **illegitimate births** to be separately accounted for. **Still births** are not registered as births or deaths. As a rule, in all civilized countries, there is a steady decline of birth-rates owing to causes like—postponement of marriage till late in life, increased celibacy, restricted widow remarriage, malthuseanism, higher infantile mortality in towns, epidemic diseases, diminished fecundity. The birth-rate is lowest in agricultural districts, highest in industrial districts ; lower in the latter, higher in the first, halves of a year ; lower among the poor.

The birth rate is calculated as annual rate to 1000 persons living and is found by—

1000 × (*Number of births in the year*) ÷ Population in the middle of the year.

The birth rate for shorter periods (weeks, months &c.) may be calculated by

$$1000 \times n \times \frac{\text{Number of births during the period in questions}}{\text{Population in the middle of the. year}}$$

Birth rate on census population of Calcutta (per 1000) :—1901—10·7, 1902—14·2, 1903—15·5, 1904—17·9, 1905—18·4, 1906—17·7, 1907—19·1, 1908—20·1, 1909—22·9

Death or Mortality Rate.—Death rate is *crude* when it relates to the number of deaths per annum per 1000 of the mean population living at all ages ; it is called *recorded*, when it is calculated in the same way as the crude, minus the deaths in hospitals &c.; it is called *corrected*, when corrected as regards death in public institutions and as regards age and sex distribution of the population; it is *standard*, when it refers to the average death rate at all ages during the previous intercensal decade. Death rate gives no idea of the health of a part, because, often a hospital, an asylum, a workhouse in any district may show death-rates out of proportion to the normal death-rate of that district; again, while many sick people migrate to towns for better treatment, others migrate to villages for a change of air and die there; in manufacturing towns, the aged ones are less, the healthy young ones are more, in number. Death rates are largely influenced by birth rates and density of population. Females at all ages have lower death-rates than males.

Infantile Mortality:—Children under 5 and old people over 55 years of age die at a greater rate; children under 5 die three times as often as people of all ages together. A high birth rate for a short period is coincident with a high death rate, until the high birth rate continues long. But high death rates are not the result of high birth rate. The causes of infantile mortality are: immaturity, ignorance, poverty or age-disparity of parents; insanitation, illegitimacy, accidents during birth, premature birth, overlying, congenital defects, hereditary tendency, improper food, epidemics &c. Infantile mortality is the greatest on the first day of life, and in mining and textile districts; continues high throughout the first week, half the mortality occuring in the first three months of life; and is lowest in—the last three months of first year of life, in poverty and in agricultural districts. It is much higher among males than females. Infantile mortality is best calculated from birth returns by finding out the rates of death of infants under one year to the number of actual births in the latter half of the preceding and former half of the current years. Infant mortality is an index of the density of population and local sanitation.

The **formulae** for finding out—

Crude Death Rate :—

Annual : $\frac{1000 \times \text{Death from all causes in the year}}{\text{mean population}}$;

Monthly : $\frac{1000 \times \text{number of deaths in a month}}{\text{Monthly population}}$;

Weekly : $\frac{1000 \times \text{number of deaths in a week}}{\text{Weekly population}}$

[The monthly population = mean population ÷ 11·8 (months); weekly population = mean population ÷ 52·17747 (weeks)].

Standard Death Rate : $= \frac{\text{Total calculated deaths} \times 1000}{\text{population}}$

Corrected Death Rate :— = Recorded death rate × Factor

[Factor = Factor of correction for age and sex distribution =

$\frac{\text{Standard death rate for whole Country}}{\text{Standard death rate for the place}}$]

Comparative Mortality figures are obtained by dividing the (corrected death rate × 1000) by the death rate of the whole country.

Infantile Mortality is found thus :—

$\frac{1000 \times \text{Deaths of children under 1 year}}{\text{Births registered during the year}}$

Combined death rate of two or more districts

$= \frac{\text{total deaths} \times 1000}{\text{total population}}$

Density of population.—The density should refer to the number of persons in each room rather than over a given area. By polluting the air, water and soil, by increasing filth, crime, drinking and debauchery, by easily spreading infectious diseases, by making life more strenuous and by being associated with dangerous and noxious trades, density of population is a great factor in the death rate. Death rate does not increase in direct proportion to the 6th roots of the contrasted populations—and that only after the density has reached a certain degree of intensity. The density of population is calculated from this formula :—Area (in acres) ÷ population.

Occupational Mortality.—It has been carefully ascertained that the following diseases are specially fatal to the callings noted against each :—*Influenza*—doctors ; *Diabetes*—school masters, judicial officers, lawyers, doctors, inn keepers ; *Phthisis*—inn and hotel servants, lead miners, file makers, cutlers, potters &c. It will be evident, therefore, that it is important to ascertain the number and age (in groups like 25 to 35, 35 to 45, 45 to 55, 55 to 65) of persons engaged in each calling and then the Disease Comparative Mortality Figure can be calculated thus :—

(Death in one age group × 1000) ÷ working population in that group.

Cause of Death.—A statistical study of the causes of death in a country, specially of deaths from *Zymotic* diseases, sometimes gives an insight into the sanitation of the place. According to the Registrar-General, the seven principal Zymotic diseases are : small pox, measles, scarlatina, diphtheria, pertussis, fever (typhus, enteric, simple continued) and diarrhœa. Thus, while deaths from diphtheria, phthisis, enteric fever, small pox, cholera, &c. give an idea of the sanitation, they all being traceable to insanitation, heavy mortality from whooping cough and measles conveys no such idea, because, these two are not due to any insanitary conditions, so far as we know. Zymotic death rate

=(number of deaths from the seven principal zymotic diseases × 1000) ÷ population.

Regarding the influence of age upon mortality figures, it is well known that small pox, measles, diarrhœa, diphtheria and whooping cough are most fatal to the infants; phthisis to middle age (12 to 47), and cancer after 28th year, and so on.

Sickness.—Compulsory registration and notification of sickness by factory and work house medical officers and notification of infectious diseases by all practitioners would if carefully made, enable preventive measures to be taken in advance. But unfortunately, there is a great deal of apathy in this respect.

Marriage.—Instead of stating the proportion of marriages to the 1000 of population, it would be more accurate to base the marriage rate on the number of unmarried persons living at marriageable age. In western countries, the marriage rate is higher in towns owing to better prospects in life and higher wages. No such practice holds in India.

Determination of Longivity.—If the duration of individual life is uncertain, that of communities is almost a mathematical certainty. Hence its importance in judging the sanitation of a community. The average or mean longivity is measured by this formula: Mean age at death = sum of ages at death ÷ number of deaths. As a rule, it is lowest in countries with a high birth-rate and for purposes of comparison between any two classes as to their relative vitality, the figures are meaningless.

Certain terms are frequently used in this connexion and their meaning and import are as follow: (1) "*Probable* duration of life," "Equation of life" or "vie probable"—refers to the age at which exactly half of any given number of children born alive will have died. This is of slight value as a test of communal longivity and can be ascertained in practice from life tables. (2) "*Mean* duration of life", or "vie moyenne"—is the present age in years + probable duration of life after having attained a given age. This can be calculated from Farr's formula :

$$x=\left(\frac{2}{3}\times\frac{1}{d}\right)+\left(\frac{1}{3}\times\frac{1}{b}\right)$$

where x=expectation of life at birth, b=birth rate, d=death rate per unit of population. (3) "Mean after life time" = the probable duration of life after having attained a given age. It can be calculated thus :—

$$x=\frac{2}{3}\times\frac{1000}{D}+\frac{1}{3}\times\frac{1000}{B}$$

where, x=expectation of life at birth, D=death rate, B=birth-rate. (4) Expectation of life at birth = the average number of years which a person at a given age lives—not the number of years that an individual may expect to live. For ages between 25 and 75, Wallich gives this formula : If x= expectation of life and a=present age, then $x=\frac{2}{3}(80-a)$. (5) Life Table or biometer = table constructed from census figures on the basis of the number living and the number dying at each age. A life table can be either annual or quinquennial and "it measures the probabilities of life and death of this generation at birth and of the survivors at each successive age period until the whole generation is extinct."

Life table is thus constructed : (*a*) From the census returns calculate the death rate per 1000 living for each age or group of ages ; call this D. (2) Calculate the ratio of the final to the initial population by—

$$(1000-\tfrac{1}{2}\,D)\div(1000+\tfrac{1}{2}D)$$

assuming death to be evenly distributed over the whole age period, so that half the deaths occur in the first portion of the period and the other half in the second portion. The first life table was constructed by Farr (1838 to 1854) and the second by Tatham (1881—1890).

"To find the expectation of life at any age x, add together the years of life lived through by the whole of the life-table population after that age and divide by the number of survivors at that age."

Comparing Indian and English statistics as regards expectancy of lives, the former are at a distinct disadvantage.

APPENDICES.

1. *Formula for calculating the amount of* CO_2 *given off in cft. per hour :—*

(Number of respirations × cub. inches of air passed into and out of lungs × 60 minutes) ÷ 1728

Thus—

$\frac{17 \times 30 \text{ cub. in.} \times 60}{1728} = 17\frac{2}{3}$ cub. ft. air per hr. and 4% of $17\frac{2}{3} = 0{\cdot}72$ cub. ft. of CO_2 per hr.

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2. *To find the volume of a gas at a given temperature and pressure :—*

$$\begin{aligned} v &= V + Vct \\ &= V(1 + ct), \end{aligned}$$

where v = volume at t°C., V = volume at 0°C, c = coefficient of expansion and t = temperature.

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3. *To find out the cubic feet of air required per person per hour :—*

Formula : $D = \frac{E}{r} \left[\therefore r = \frac{E}{D}\right]$ ($D \times 1000$ = required delivery of fresh air in cubic feet per hour (3000 per head) ;

e = cft. of CO_2 exhaled in an hour per head (= ·6 the average) ;
p = limit of respirable impurity per cub. feet (·2 of a cft. CO_2 per 1000 cft. of air).

Example : If 2000 cft. of air per head be supplied, find the amount of CO_2 present. Here $2000 = D \times 1000 = 2$. Hence,

$$2 = {\cdot}6r = \frac{{\cdot}6}{2} = {\cdot}3. \quad \text{Thus } {\cdot}3 + {\cdot}4 = {\cdot}7.$$

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4. *To find from the condition of the air, the amount of fresh air that has been supplied and used :—* $\frac{e}{p1} = d.$

Supposing impurity $=1 \cdot 1$, then $\dfrac{\cdot 6}{\frac{1 \cdot 1 - \cdot 4}{1000}} = d = 857$ cub. ft.

5. *To ascertain the probable condition of the atmosphere of a room into which a given quantity of air has been admitted, the formula is :—*

$$\frac{e}{d} = p1$$

[Example : *Q.* What amount of CO_2 per 1000 of air would be found in a room of 6000 cubic ft., occupied for 6 hours by 5 persons where 8000 cub. ft. of air per hour have been supplied? *Ans.*—

$\cdot 6 \times 6 \times 5 = 18$.

Then $\dfrac{18}{54000} = p1 = \cdot 0033$ per cubic feet or $\cdot 33$ per 1000

Examples : (*a*) Find the air supply per head per hour necessary in a hall of 25000 cft. occupied by 500 people, so as to keep down the CO_2 at $\cdot 8$ parts per 1000.

$$d = \frac{\cdot 6 \times 500}{\cdot 8 - \cdot 4} = \frac{300}{\cdot 4} = 120 \text{ cft.}$$

$\therefore d \times 1000 = 120000$ and $120{,}000 - 25000 = 95000$ and $95000 \div 500 = 18$ cft. per head per hour.

(*b*) Calculate the amount of CO_2 per 1000 volumes in the air of a 5000 cft. room occupied by 5 men for 6 hours during which 10000 cft. of fresh air has been supplied per hour.

$r = \dfrac{E}{D} = \dfrac{\cdot 6 \times 5 \times 6}{4 \times 10000 + 5000} = \dfrac{18}{45000}$ per unit $= \cdot 0004$ per unit $= \cdot 4$ per 1000. Now $\cdot 4 + \cdot 4$ (initial impurity)—$\cdot 8$ cft.

6. *Specific heat*=the amount of heat necessary to raise a unit mass of a body through one degree of temperature. The Sp. heat of a body is greater in its liquid than in its solid or gaseous forms; in the case of gases, the Sp. heat does not vary with the temperature or density of the gas. The standards in England and France are respectively—for 1℔ through 1°F and 1 kgrm. of ice-cold water through 1°C.

7. *Rainfall*: [*one inch of rainfall* = 4·67 gallons per sq. yd. = 101 tons per acre.]

To calculate in cub. ft. the amount of rainfall:—

$$= \frac{\text{Area (in sq. ft.)} \times 144 \times \text{rainfall (in inch)}}{1728}$$

[*Note* (*a*) 1 cub. ft. water = 6·23 gallons]. (*b*) If the receiving surface is a slope, we neglect that fact and take its real area in sq. ft.

To calculate rainfall per head per year over a known area:—

(*a*) Area (in sq. ft.) × $\frac{1}{2}$ rainfall (in inch) = gallons per year.

(*b*) Area (in sq. ft.) × rainfall (in feet) = cub. ft. of water.

To calculate from the collection of the Rain Gauge:—Supposing the gauge is 8 in. in diameter, then—

the area of the opening $= d^2 \times 0{\cdot}7854$

$= 16 \times 3{\cdot}1416$

$= 29{\cdot}08$ oz.

Place therefore 29·08 oz. water into the glass measure and mark off the level of the surface of water.

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8. *To estimate yield of a stream*:—

(*a*) Find average depth and breadth in four or five places.

(*b*) Find the mean velocity of the stream in ft. per second.

[This = $\frac{4}{5}$ of surface velocity]. Now—

Sectional area × mean velocity = flow in cub. ft. per second.

[cub. ft. × 6·23 = gallons of water].

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9. *Pettenkofer's Estimation of CO_2 in a sample of air*:

The principle is this: At the rate of 4 litres per hour, aspirate 10 litres of air through a 100 cc. solution of barium hydrate (7 grammes to the litre) contained in a series of Pettenkofer's absorption tubes. The strength of this solution is determined by a solution of oxalic acid such that 1 cc = ·4 cc of CO_2 at O°C and 760 mm. Hg.

[Take a wide-mouthed stoppered jar of 4840 cc. Take also a standard solution of oxalic acid (= 2·25 grammes per litre), 1 cc of which exactly neutralizes 1 mgr of CaO—*i.e.*, each 1 cc of oxalic acid=·4 cc of CO_2, at 0°C and 760 mm of mercury—either being capable of neutralizing 1 cc of CaO].

Into the jar put 60 cc $Ca(OH)_2$ and aspirate into it air at the rate of 4 litres per hour ; if after a time (8 hours) we find that 30 cc of lime water has taken respectively 38 and 31 cc oxalic acid solution before and after the process, tben—

4840 (Vol. of air)—60=4780 cc.

Now 30 cc of $Ca(OH)_2$ lost $38-31=7$ mgr. of CaO.

∴ 60 cc lost 14 mgr of CaO.

Now $14 \times \cdot 4 = 5{\cdot}6$ cc of CO_2 in 4750 vols. of air [or 1·17 per 1000].

[If t=72°F and barometric pressure is 29·2, then

$$1{\cdot}17 \times \frac{108}{100} \times \frac{30}{29{\cdot}2} = 1{\cdot}3,$$

1% being added for everp 5° above 32°F].

10. (*a*) Gas diffuses at the rate of $\frac{1}{\sqrt{D}}$

(*b*) *Montgolfier's Formula* is—

$V^2 = 2G\,(H-h)$, where H=26,400 ft.=5 miles.

(*c*) The usual current up a chimney is—3′·6″ a second.

11. *Permissible limits of Impurities of water :*

Chlorine—$\frac{4}{100,000}$ Free Ammonia $\frac{0{\cdot}005}{100,000}$

Nitric Acid $\frac{0{\cdot}5}{100,000}$

Hardness. Total 17·3 Fixed 5·7 Albumnioid Ammonia $\frac{\cdot 01}{100,000}$

12. *The amount CO_2 in the soils* at a depth of—

4 ft.—is 2 vols. per 1000 of soil air
7 ft.—is 30 „ „ „ „
20ft.—is 80 „ „ „ „

The amount of Oxygen is inversely as the amount of CO_2

13. (*a*) *To obtain "Dew point"*—"take the difference between the wet and dry bulb temperatures in Glaisher's tables and deduct the product from the dry bulb temperature."

(*b*) *To obtain Relative Humidity* :—

$$100 \times \frac{\text{weight of 1 cub. ft. of air Vapour}}{\text{weight of 1 cub. ft. of saturated air at same temp.}}$$

Ordinarily,

$$\left.\begin{array}{llll} \text{At } 0^\circ\text{F}, & \text{a cub. ft. of air takes up} & & 0{\cdot}55 \\ 52^\circ\text{F} & \text{,,} & \text{,,} & 4{\cdot}39 \\ 96^\circ\text{F} & \text{,,} & \text{,,} & 17{\cdot}68 \end{array}\right\} \text{gr. of } H_2O.$$

---

14. *To find out the amount of dry solid manure from human excreta.*—Fresh foeces contain 23·4% and urine 4·2% of dry solids—54% of the latter being urea.

Example : State the amount of *dry* solid manure produced daily by a population of 10,000, where the pail system is in force and all the foeces and only ⅓ urine are collected in the pails.

Answer :

$$\left(10{,}000 \times 2{\cdot}5 \times \frac{23{\cdot}4}{100}\right) = 5850 \text{ oz in foeces.}$$

$$\left(10{,}000 \times \tfrac{1}{3} \times 40 \times \frac{4{\cdot}2}{100}\right) = 5600 \text{ oz in urine.}$$ Now $5850 + 5600 = 715{\cdot}6$ lb $= {\cdot}32$ ton.

[If instead of being dry, this manure contain 25% moisture, it will weigh $\frac{4}{3}$ of $0{\cdot}32 = 0{\cdot}43$ ton ; if 50% then $2 \times 0{\cdot}32 = 0{\cdot}64$ ton ; if 75% then $4 \times 0{\cdot}32 = 1{\cdot}28$ ton ; if 90%, then $10 \times 0{\cdot}32 = 3{\cdot}2$ tons].—Parkes.

---

15. *The quantity of Nitrogen voided per head daily* by a mixed population = 153 gr. = 186 gr. of NH_3.

---

16. *To find the area of a Room of irregular shape* :—[If a room is rectangular in shape, its area = Length × Breadth × Height. Square inch is converted into sq. ft by multiplying by 0·007].

Area of—

Circle = $(\text{Diameter})^2 \times 0{\cdot}7854$

= Circumference × 0·0796

Segment of a circle $= (\frac{2}{3} \times \text{chord} \times \text{height}) + \frac{\text{cube of height}}{2 \times \text{chord}}$.

'Segment' of a circle = Area of base $\times \frac{2}{3}$ height

'Circumference' of a circle $= 2\, r\, \pi$, where r = radius

$$\text{and } \pi = \frac{22}{7} = \frac{\text{circumference}}{\text{diameter}}.$$

Space with curved sides.—Divide into triangles and segments of a circle; then $\frac{\text{Height}^3}{2 \text{ chord}} + \frac{2}{3}$ (Height × chord).

Cylinders = area of end × height.

$= (\text{Radius})^2 \times 3 \cdot 1416$.

Ellipse = long diameter × short diameter × 0·07854

Square = $(\text{any side})^2$

Triangle = height $\times \frac{1}{2}$ base

= base $\times \frac{1}{2}$ height

Rectangle = product of 2 adjacent sides. Any figure bounded by straight lines = divide it into triangles and add together their areas.

Trapezoid = half the sum of the parallel sides × the perpendicular distance between them.

Circumference of—

Circle = diameter × 3·1416.

Ellipse = $\frac{1}{2}$ sum of 2 diameters × 3·1416.

Diameter of a circle = circumference × 0·3183.

Cubic Capacity of—

Triangle (solid) = area of △ $\times \frac{1}{3}$ height.

Rectangle (solid) = L × B × H.

Cylinder = area of base (circle) × height.

Cone or Pyramid = area of base (circle) $\times \frac{1}{3}$ height.

Dome = area of base (circle) $\times \frac{2}{3}$ height.

Sphere $= D^3 \times 0 \cdot 5236$.

Mean height = (maximum height + minimum height) ÷ 2. This is necessary to find out in cases of sloping roofs.

17. *To find average floor space per occupant*—(It should be $\frac{1}{12}$ of total cubic space) (*a*) Divide area of floor by number of inmates. (*b*) From the result obtained deduct cubic area of furniture, projections, human beings, (weight in stones÷4), bed and beddings (10 cft.) (*c*) Add cubic space of recesses to the result.

18. *Weight of watery vapour which 1 cub. ft. of air can hold at*—

30° F	2 gr.	74° F	9 gr.
41° F	3 ,,	77° F	10 ,,
49° F	4 ,,	80° F	11 ,,
56° F	5 ,,	83° F	12 ,,
61° F	6 ,,	86° F	13 ,,
66° F	7 ,,	88° F	14 ,,
70° F	8 ,,		

19. *Weight of air*: Air is 773 times lighter than water. At 60° F and barometer at 30″, 100 cub inches of—

Dry air weigh 31 gr.
,, CO_2 ,, $47\frac{1}{4}$ gr.
,, H ,, $2\frac{1}{7}$ gr.

Atmosphere of the whole Earth—is not less than 40 miles in height.

Weight of air— over

one sq. inch = $14\frac{3}{4}$ ℔
,, sq. ft. = 1 ton (nearly)
one man's body = 16 tons

Moist air is lighter than dry air. Air at a higher temperature is lighter than air at a lower temperature—as *air expands* at the rate of $\frac{1}{491}$ = O ·00203 of its volume for each degree F.

20. *Velocity of Ventilating air* (per second) is calculated by this formula :—

$$V = \sqrt{2ga(t' - t)h}$$

where g = accelerative velocity due to earth's gravity.
a = coefficient of expansion of air for each degree of temperature.

t'=temperature of heated column of air.
t=temperature of cold air
h=height through which the body falls.

[Montgolfier's Formula, modified] or according to this :—

$$V=8\sqrt{\frac{(h-h')(t-t')}{491}}$$

$$\left.\begin{array}{l}\text{where } h=\text{height of aperture of exist}\\ h'=\quad\text{,,}\quad\text{entrance}\end{array}\right\}\text{from ground.}$$

$$\left.\begin{array}{l}t=\text{temp. of air inside}\\ t'=\quad\text{,,}\quad\text{,,}\quad\text{outside}\end{array}\right\}\text{in Fah Temp.}$$

21. *To calculate (in feet) amount of air leaving by a chimney-flue* : Multiply the velocity of the wind by the sectional area of the flue in inches divided by 144. Thus if V=7 and sectional area =126 sq. in., then—

$$7\times\frac{126}{144}=6.1 \text{ cub. ft. per second.}$$

$$\therefore 21960 \text{ cub. ft. per hour.}$$

22. *To find out the work done (in foot tons) by a man going up a height,* $\frac{(W+W_1)\times D\times 5280}{2240}\times c=$ foot tons.

where, W =weight of the man (in lb.) W^1=weight carried by the man (in lb.) D=distance walked (in miles) C=coefficient of traction.

23. *To estimate the weight (in lb.) of a slaughter-animal from measurements of it* :—

$$W=\tfrac{2}{3}\,(5L\times G^2)+\tfrac{1}{20}w$$

where W=weight of whole animal required in lb.

w=weight obtained by the portion of the formula preceding "$+\frac{1}{20}w$" L=length of trunk—from front of scapulae to root of tail. G=girth, just behind scapula.

24. *To find out the quantity of food required*—

(1) Read off from the tables of percentage composition of the foods the quantities given for each article under the heads of the several proximate principles ; and (2) add them together.

Thus, if for ordinary work, a diet of bread, butter and meat is ordered, the quantities required are found thus :—

Let x=oz of meat required per head,
y=oz of bread ,, ,,
z=oz of butter ,, ,,

Then, $\frac{20.5}{100}x+\frac{8}{100}y+\frac{1\cdot5}{100}z=4\cdot5$ *oz* Proteid.

$$\frac{8\cdot5}{100}x+\frac{0\cdot5}{100}y+\frac{83\cdot5}{100}z=3\cdot5 \textit{ oz } \text{Fat.}$$

$$\frac{50}{100}y+\frac{1}{100}z=14 \text{ oz carbohydrates.}$$

Double these (which are waterfree) and we get—

Meat 10·8 oz, Bread 28 oz and Butter 3 oz. [The percentage composition table shows—

Meat=20·5 prot. 8·5 fat 0 carb.
Butter=1·5 ,, 83·5 ,, 1·0 ,,
Bread=8·0 ,, 0·5 ,, 50·0 ,,]

---

25. *To find out the total calories yielded by 100 grammes of any food*, multiply the percentage in grammes in the case of—

proteid × 4·1
carbohydrate × 4·1
fat × 9·3

---

26. *To calculate foot tons of energy obtainable from a diet :*

[Joule found out that the mechanical power obtained from a given amount of fuel is directly proportional to the amount of fuel used. But in the case of the body, its metabolism is not identical with oxidation outside. Frankland estimated that—

1 oz. dry proteid	yields	174	foot tons of potential energy.
,, fat	,,	378	
,, carbohydrate	,,	135	
,, cane sugar	,,	129	
,, glucose, lactose	,,	122	

Q. How much work in foot-tons can be expected from a diet of 10 oz cooked beef, bread 24 oz., butter 1 oz and potatoes 20 oz?

From table of percentage composition of food we find that the total—

Proteid of the above three = 4·9 oz
fat „ = 2·94
carbohydrate „ = 16·6.

∴ (4·9 × 174) + (2·94 × 378) + (16·6 × 135) = 2188·02 foot tons.

From this table, it is easy to estimate the caloric value of any scale of diet, by the simple process of multiplication; thus, if the proteid allowed in 24 hours is 4·5 oz, its caloric value = 4·5 × 116 = 522 calories.

[We accept the estimate of heat required at—

(*a*) 2800 calories (English) = 4280 foot tons = 8562400 foot tons = 1,200,000 kilogramme metres.

(*b*) 3500 calories (American) = 1,488,250 kilogramme metres = 10,771,600 foot pound].

---

27. A thermal unit = 0·45 calorie
A calorie = 2·2 thermal units
A thermal unit = 1390 foot pounds
= 0·695 foot tons
A calorie = 425·5 kilogramme metre
= 425,500 gramme metres
= 3077·6 foot pounds
A kilogrammemetre = 7·233 foot pounds
1 foot pound = 0·138 kilogramme metre

---

28. The following proximate principles, when burnt, give the following amounts of heat and work:—

	Calories Per Gram	Calories Per oz	Foot tons	Kilogramme metres
Proteid	4·2	116·26	6·4	1787
Fat	9·3	263·70	14·2	3957
Carbohydrate ...	4·1	116·25	6·3	1744

---

29. *To estimate amount of space required for storing water.*

(1) $$\frac{\text{Number of gallons used daily}}{6\cdot23} \times \text{Number of days.}$$

(2) *Hawksley's Formula—*

$D = \frac{1000}{\sqrt{F}}$, where D = number of days for which storage is required ; F = mean annual rainfall.

To estimate cub. ft. of water passing through a sluice per minute :

$$5\sqrt{\text{Breadth of sluice in ft.} \times \text{Height of opening in ft.}}$$

But if sluice is under water, then take the difference in level between water above and below the dam ; if sluice is not wholly under water, then take the height of the water in the dam above the centre of the sluice.

30. *Amount of nutrient required by children.*

Age of child.	Weight of child. Kils	℔	Protied (Oz)	Fat. (Oz)	Carbo-hydrate (Oz)	Carlories
Sixth *day*	2·5	5·5	0·25	0·4	0·53	1923
2nd week, End.	2·8	6	0·42	0·67	1·0	346
4 Months	4·5	10	0·66	1·0	1·41	516
1½ years	9	20	1·4	1·27	2·8	827
3 „	12·6	28	1·5	1·4	6·66	1314
4 „	17·4	37·3	2·15	1·53	6·7	1438
6 „	18	39·0	2·2	1·6	6·9	1489
8-9 „	—	—	2·1	1·5	5·3	1270
12-13	—	—	2·5	1·6	8·6	1808
14-15	—	—	2·8	1·7	9·5	1877

31. *Nutrient Ratio and Value of chief cereals and pulses* :

	Nutrient Ratio.	Nutrient Value.
Wheat	1:5	84
Rice	1:1·08	86·5
Maize		...
Millet	1:6	...
Gram	1:3·3	84
Masoor dal	1:2·5	85
Peanut	1:5·4	151
Teor dal	1:1·75	87
Soya Beans	1:2	105
Mung dal	1:2·5	83
Simbi	1:2·5	80

32. *Hardness of water.* The amount is expressed in terms of grains of $Ca\ CO_3$ per gallon. In clarkes system, each grain = 1° clarke = 0·7° metrical. A soap solution is used to secure the necessary precipitation.

Limit of Total Hardness—is 30° metrical and of this the permanent hardess should not exceed 5° metrical. The more objectionable is the water. The usual amount of hardness met with in water is—very soft water, 6° to 8° metrical, ordinary soft water 8° to 15° metrical and Hard water 20 to 30° metrical.

33. *To convert Grains into parts per gallon :*

$$\frac{100000 \times 10}{7}.$$

34. *Thermometric Scale.*

F	C	F.	C.	F.	C
212°	100	122	50	32	0
210	98·9	120	48·9	30	— 1·1
208	97·8	118	47·8	28	— 2·2
206	96·7	116	46·7	26	— 3·3
204	95·6	114	45·6	24	— 4·4

F	C	F	C	F	C
202	94·4	112	44·4	22	— 5 6
200	93·3	110	43·3	20	— 6·7
198	92·2	108	42·2	18	— 7·8
196	91·1	106	41·1	16	— 8·9
194	90	104	40	14	—10
192	88·9	102	38·9	12	—11·1
190	87·8	100	37·8	10	—12·2
188	86·7	98	36·7	8	—13·3
186	8·6	596	35·6	6	—14·4
184	84·4	94	34·4	4	—15·6
182	83·3	92	33·3	2	—16·7
180	82·2	90	32·2	0	—17·8
178	81·1	88	31·1	— 2	—18·9
176	80	86	30	— 4	—20
174	78·9	84	28·9	— 6	—21·1
172	77·8	82	27·8	— 8	—22·2
170	76·7	80	26·7	—10	—23·3
168	75·6	78	25·6	—12	—24·4
166	74·4	76	24·4	—14	—25·6
164	73·3	74	23·3	—16	—26·7
162	72·2	72	22·2	—18	— 27·8
160	71·1	70	21·1	—20	—28·9
158	70·0	68	20	—22	—30
156	68·9	66	18·9	—24	—31·1
154	67·8	64	17·8	—26	—32·2
152	66·7	62	16·7	—28	—33·3
150	65·6	60	15·6	—30	—34·4
148	64·4	58	14·4	—22	—35·6
146	63·3	56	13·3	—34	—36·7
144	62·2	54	12·2	—36	—37·8
142	61·1	52	11·1	—38	—38·9
140	60	50	10	—40	—40
138	58·9	48	8·9	—42	—41·1
136	57·8	46	7·8	—44	—42·2
134	56·7	44	6·7	—46	—43·3

F	C	F	C	F	C
132	55·6	42	5·6	—48	—44·4
130	54·4	40	4·4	—50	—45·6
128	53·3	38	3·3	—52	—46·7
126	52·2	36	2·2	—54	—47·8
124	51·1	34	1·1	—56	—48·9

Formulae for conversion—

$$F=\frac{9C}{5}+32 \qquad C=\frac{5(F-32)}{9}$$

$$=\frac{9R}{4}+32 \qquad R=\frac{4(F-32)}{9}$$

---

35. *Conversion of Metric into English measures.*

1 acre =4840 sq. yd. $=\frac{1}{640}$th mile
1 sq. mile =640 acres
1 sq. ft. =144 sq. in.
1 sq. yd. = 9 sq. ft.
1 sq. metre =10·764 sq ft.
1 pint =·57 litre $=\frac{1}{8}$ gallon =·02 cub. ft. =20 oz.
1 gallon =4·54 litre =·16 cub. ft. =277·25 cub. in.
1 ounce =28·35 c. c. m. and 1·728 cub. in.
1 cub. in. =·0058 cub. ft.
1 „ ft. =1728 cub. in. =6·25 gallons =21·3 litres =1000 ounces
1 litre =1000 c. c. m. =35·3 oz =·22 gallon =61·06 cub. in.
1 cub. metre =35·316 cub. ft.

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36. *Over or under Proof*:—Pure or absolute alcohol is lighter than and highly miscibe with water. The more the water is added to alcohol, the less it burns till at length it will not burn at all. A little spirit is poured over gun powder and fire is set to it; if the powder explodes it is *over proof*, if it did not, the spirit *was under-proof*. On this basis, *proof spirit* (=57·05 alcohol+Aq. destil 42·95) is taken as standard—there being 1 part of alcohol in 1·753 parts of proof spirit. Hence, a spirit that is—(*a*) 10° over proof

contains in 100 volumes as much alcohol as 100+10 volumes of proof spirit; (*b*) 10° under proof—contains in 100 volumes as much alcohol as 100—10 volumes of proof spirit.

To compare a spirit with proof spirit,=(Percentage vol. of alcohol) × 1·753 less or less from 100 according as it is over or under proof.

To find out percentage of alcohol, give the strength under or over proof.—

$$\frac{100 \mp \text{strength given}}{1{\cdot}753}$$

(—in case of under and + of over proof)

---

37. *To calculate capacity of latrine cistern.*

$$\frac{\text{Number of persons} \times 5 \text{ gallons}}{6{\cdot}23} = \text{cub. ft.}$$

To calculate discharge from sewers:

$$V = 55\sqrt{D \times 2F}$$

Where V = Velocity of flow in feet per minute
D = hydraulic mean depth
F = fall in feet per mile.

---

38. *Metric and English equivalents:*

1 metre (*m*) = 10 Decimetres (Dm)
= 100 cente „ (cm)
= 1000 Milli „ (mm)
10 metres = 1 Deka metre (dm)
100 „ = 1 Hecto „ (hm)
1000 „ = 1 Kilo „ (km)
1 milligram = 0·001 gramme = $\frac{1}{66}$ grain approximately
1 centigram = 0·01 gramme = $\frac{1}{6}$ „ „
1 decigram = 0·1 gramme = $1\frac{1}{2}$ „ „
1 gramme = 15·432 grains = $15\frac{1}{2}$ grains „
1 kilogram = 1000 grammes = $2\frac{1}{5}$ pounds avoir
1 millilitre ("mil, "formerly "c. c.") = 0·001 litre = 17 minims approximately.

1 millimetre = 0·001 metre = $\frac{1}{25}$ inch approximately
1 centimetre = 0·01 metre = $\frac{2}{5}$ „ „
1 decimetre = 0·1 metre = 4 inches „

1 metre = 39·370113 in.	1 in. = 2·54 cm.
= 3·280843 ft.	1 ft. = 30·48 cm.
= 1·0936 yd.	1 yd. = 0·9144 m.
1 km = 0·62137 mi.	1 mile = 1·6093 km.
1 litre = 61·0238 (in)^3	1 (in)^2 = 6·4516 (cm)^2
= 35 ft. ounces	
= 1·76 pint	1 (yd,^{2} – 0 8361 (m)^2
= 0·22 gallons	1 (ml)^2 = 2·59 (km)^2
1 grm = 15·43236 gr.	1 gr = 0·0648 gr.
1 kg = 2·20462 lb.	1 ℔ = 0·4536 kg.

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39. *Table of conversion.*

To convert	grammes ...	to pounds,	multiply by	0·0022
„	„ ...	to grains,	„	15·432
„	„ ...	to ounces	„	0·0353
„	grains ...	to grammes,	„	0·0648
„	ounces ...	to „	„	28·349
„	pounds ...	to „	„	453·715
„	kilogrammes ...	to pounds,	„	2·204
„	„ ...	to ounces,	„	35·3
„	litres ...	to gallons,	„	0·22
„	„ ...	to fluid ounces	„	35·3
„	„ ...	to pints	„	1·76
„	„ ...	to cubic feet,	„	0·0354
„	„ ...	to cubic inches,	„	61·027
„	gallons ...	to cubic feet,	„	0·1605
„	„ ...	to litres,	„	4·5371
„	pints ...	„	„	0·5679
„	„ ...	to cubic centimetres	„	568·1818
„	„ ...	to cubic inches.	„	34·67
„	cubic metres ...	to gallons,	„	220·4
„	„ ...	to pints,	„	1763·2
,	, ...	to fiuid ounces,	„	35264·0

To convert	cubic metres...	to cubic centimetres,	multiply by	1000000·0
,,	cubic feet ...	to cubic metres,	,,	0·0283
,,	,, ...	to litres,	,,	28·318
,,	,, ...	to gallons,	,,	6·2322
,,	fluid ounces ...	to cubic inches,	,,	1·7299
,,	,, ...	to cubic centimetres,	,,	28·35
,,	square feet ...	to square metres,	,,	0·0929
,,	,, ...	to square yards,	,,	0·111
,,	square metres	to square feet,	,,	10·7641
,,	inches ...	to metres,	,,	0·0254
,,	,, ...	to millimetres,	,,	25·4
,,	metres ...	to inches,	,,	39·37
,,	,, ...	to feet,	,,	3·28
,,	feet ...	to miles,	,,	0·000187
,,	yards ...	to miles,	,,	0·00057
,,	,, ...	to centimetres,	,,	91·44
,,	centimetres ...	to inches,	,,	0·3937
,,	millimetres ...	to ,,	,,	0·03937
,,	kilometres ...	to miles,	,,	1·6
,,	square kilometres	to square miles,	,,	2·5899
,,	hectares ...	to acres,	,,	0·4046

Grains per gallon into parts per 100,000 = Grains per gallon × 10 and ÷ 7.

Parts per 100000 to grains per gallon = parts × $\frac{7}{10}$.

20. *1 calorie* = energy required to raise the temperature of 1 kilo. (1 litre) of water 1·*c* = 425, 500 units of work (gramme-metres).

To convert.—

(1) Gramme-metres × ·007233 = foot lb.
(2) ,, ÷ 311,000 = foot tons.
(3) Kilogramme-metres × 7·233 = foot lb.
(4) ,, ÷ 311 = foot tons.
(5) Calorie × 136 = foot tons.
(6) Total calorie × 3077 = foot pounds.
(7) ,, × 425.5 = Kilogramme-metres.

Infectious Diseases.

Disease.	*Location of Germ.*	*Incub. Period.*	*Date of Eruption.*	*Infectious Period.*	*Length of Isolation.*	*Quarantine.* Days.	*Relapses and Second Attacks.*
Erysepelas	Locally ...	1 to 3 D	24 hours	...	A week after cure ...	4	*R.* and *S. A.* common.
Influenza ...	...	2 to 3 D	Nil	...	A few days after the acute symptoms have passed.	...	Ditto.
Cerebrospinal Fever.	...	2 to 5 D	Nil	...	Till patient moves about.	...	*R.* not uncommon; *S. A.* rare.
Diphtheria	Breath ...	2 D (1 to 5).	Nil	Throughout	Until two cultures at two days' interval, negative.	6	*R.* and *S. A.* not uncommon.
Plague ...	Blood, bubs ...	3 D (1 to 5).	Nil	...	Till recovery; till discharge is germ-free.	6	*R.* occasional; *S. A.* rare.
Scarlet Fever.	Peelings of the skin and breath.	3 D ...	24 hours	Peeling stage.	4 or 5 weeks mild; 12 weeks severe purulent.	6	*R.* rare; *S. A.* not nncommon.
Relapsing Fever.	...	4 to 21 D	Nil	...	Till patient is well ...	...	*R.* common; *S. A.* not uncommon.
Whooping Cough.	Breath ...	5 to 14 D	Nil	Throughout	Till paroxysms persist ...	15	*R.* rare; *S. A.* are less so.
Measles	Breath ...	10 to 14 D	4th day	Early	21 days from rash ...	21	Ditto.
Typhus	Odour from skin	12 D ...	5th day	Throughout	4 weeks from start ...	15	Ditto.
Small-pox	Pustules breath.	12 D (10	3rd day	Final	Till the scabs drop. ...	15	*R.* nil; *S. A.* rare,
Rubella ...	...	14 D (10 to 21).	1st day	...	7 days from rash ...	21	*R.* uncommon; *S. A.* rare.
Enteric Fever.	Milk, stools, urine of patient.	10 to 15 D (5 to 23).	4th to 7th day.	...	Till recovery ...	...	*R.* common; *S. A,* rare.
Chicken-pox	Breath and pocks	12 to 21 D	1st day ...	Convalescence.	Till scabs separated ...	21	*R.* and *S. A.* are very rare.
Mumps ...	Breath and saliva	21 D ...	Nil	Throughout	3 weeks from parotitis ...	25	Ditto.

Some of the acute infections.

NAME	INCUBATION	DAY OF RASH	RASH FADES	DURATION OF ILLNESS
Typhus	12 days (5 to 14)	5th day	7th to 10th day	7to 14 days
Typhoid	10 to 15 days (5 to 23)	10th day	3d week [reappears.]	25 to 40 days
Influenza	2 to 3 days	Fastigium	Transitory	4 to 10 days
Plague	3 to 5 days	5th uncertain; petechial (?)	Uncertain	4 days to 7 weeks
Dengue	1 to 4 days	Early, not fixed.	Evanescent	7 to 10 days
Cholera	Few hours to five days	Macules, erythema of reaction.	Transitory	5 to 8 days
Variola	12 days (10 to 14)	3d to 4th day	Change 9th day; scabs.	14 to 21 days
Varicella	14 days	2nd & 3rd days	Quickly Incrustation.	7 days
Scarlatina	4 to 5 days	2d day of fever	4th to 6th day of fever.	10 days
Measles	10 to 14 days	4th to 5th day	7th day	6 to 10 days
Rubella	10 to 21 days	3d day	2d to 5th day	7 to 14 days

YELLOW FEVER: No definite rash, but skin jaundiced and often show ecchymotic spots. ERYSIPELAS: Circumscribed areas of inflamed skin and epidermal layer may be elevated. RHEUMATISM; Erythema, urticaria or purpura. DIPHTHERIA: Sometimes erythematous or purpuric rash. The skin in cerebrospinal meningitis, livid and herpes facialis, perhaps petechiae eruption and diffuseness. May be bright red, then darker purpuric spots and extensive ecchymoses.

INDEX.

Abattoir 58
Acclimatisation 346, 351
Achorion Schonlein
Actniomy cosis 205
Adulteration of food 201
Agglutinin 405
Ague 439, brass founder's 14
Air, composition of 5, diseases borne by 13, examination of 45, ground 12, 117, floating impurities of 334, mixture not chemical compound 5, moulds in 9, necessity for 4, pressure of 343, pollution of 16, sewer 12, 15, 23, supply needed 30, vitiation of 16.
Allergie 410.
Alcohol 170.
Alum 102, 265.
Ammonia 10, 112.
Amoeba dysenterica 456.
Anaerobic process for sewage 267, 273.
Analysis of foodstuffs 214.
Anaphylaxis 410.
Anemometer 329.
Aneroid barometer 326.
Angus smith process 89, 88.
Animal food 149, keeping 57.
Ankylostomiasis 462.
Anopheles 443.
Anthrax 205.
Antitoxin 407.
Ascaris lumbricoides.
Atmometer 331.
Bacteria in air 9, in milk. 147, in water 96.
Bacteriology 397.
Bacterolysin 406.
Bakehouses 62.
Barometer 325.
Bath 288.
Beverages 168
Bilharzia hæmatobia 458.
Birth-rate.
Broth.
Biological treatment of sewage 267.
Biscuit 160, 212.
Blackwater fever 452.
Blood, trade in.
Bothriocephalus latus 459.
Boyle's law.
Bran 158.
Bread 159, 212.
Bricks 127.
Bubonic Plague.
Buckwheat 161.
Building, construction of, inspection of 137.
Burial 279.
Bustee 134.
Butter 210.
Byre 199.

Calculations—See Appendices.
Calorie—See heat.
Candle 21.
Carbohydrates 154.
Carbon dioxide, amount given off 17 ; in ground air 118.
Carriers 413, 423.
Cellar dwelling 129.
Cemetries 279.
Census.
Cereals 155, 215.
Cesspools 260.
Charcoal filters 101.
Chicken pox 419.
Cholera 431.
Choubachha 94.
Cisterns 241.
Clark's process 110.
Cleanliness 286.
Climate 332, gazetteer of India (district by district) 366, of Indian hill stations. 386, of tropical Asia 393, of European and African health resorts 363.
Clothing and dress 290.
Clouds 343.
Cocoa 177.
Coffee 176, 213.
Combined system (sewers)
Condiments 178.
Conservancy system 225.
Contagium 394,
Conversion tables—See Appendix
Cooking 193.
Cooling 54.
Corpse, disposal of 281.
Cowpox 415.
Cowshed—See Byre.
Cremation 281.
Croup 420.
Cubic capacity 31, space 31, 33.
Cysticerci 205
Dairy 199.
Dampness 121.
Damp-proof course 128.
Dangerous trades 63.
Dead, disposal of 281.
Death-rate.
Dengue 419.
Deodorant 464.
Desert, climate of 338.
Dewpoint 12.
Diarrhoea, epidemic or summer 423.
Diathermancy 336.
Dibdin's filter 268.
Diet 138, in India, 189, nitrogen in 186, analysis of 214, calculations, 183, heat value of 181, for sick and invalid 193, 217.
Diphtheria 420.
Diseases, air borne 13, and dust 14, due to sewer air 15, infectious 414.
Disinfection 464.
Disposal of dead 279, of refuse 257, of sewage, 278.
Distomum hepaticum 458.
Drains, 243.
Dress, 291.
Dumping 224.
Dust 24, bin 223.

Dwelling 124.
Dysentery 435.
Eating houses 218.
Effluent 264, 278.
Eggs 151, 208.
Embalming 281.
Enteric 421.
Epidemic, investigation of an 453.
Erysepelas.
Exercise 298.
Extractives 140.
Fat melting 60.
Fell mongering 60.
Fermented milk 147.
Filaria 460.
Filter of water 99, 104, of sewage 263, bed, bacterial 273.
Filtration, downward 263.
Fire place ventilating 50.
Fish 152, 207, 214.
Fleas 463, rat, 437.
Flour 218, 212.
Flushing (Drains) 241.
Fog 353.
Food 138, adulteration of 201, analysis of 214, tinned 208, diseases due to 197.
Foundations of houses 128.
Fruits 166, 213, 216.
Fuels and illuminants 19.
Fungi 166.
Gastric fever 421.
Ghee 145, 201.
Glanders 205.
Gonorrhœa 429.
Goux system 230.
Grains and granaries 211.
Grease trap 241.
Ground air 12, water 119, 123.
Guinea worm 460.
Gully 232.
Gut cleaning &c. 60.
Haemolysin 407.
Hardness of water 66.
Health resorts, foreign 363. Indian 366.
Heat, disinfection by transmission of 49, value of food 181.
Height of rooms 32.
Hincks-Bird ventilator 38.
Hollow wall 130.
Hospital construction 136, 427.
House construction 124, cow, incellar 129, inspection 198, pilgrim lodging 133, slaughter 58, stable 57.
Humidity 11, 121, 341, 352.
Humus 115.
Hut 135.
Hydatid 205, 459.
Hygiene, achievements of 1. definition of 1, divisions of 2, personal 283, school 306.
Hygrometer 329.
Illuminants 19.
Immunity 401, 408, 402.
Impounding reservoir 71.
Incineration 224.

India, climate of 386, sanitation in 3, sanitaria in 386, hill stations in 386, pilgrim places in 364, springs in 364, climate gazetteer of 366.
Infant feeding 190, mortality.
Infection spread of, 322.
Infectious disease 394, 414.
Influenza 429.
Inlets, ventilating 37.
Inspection of buildings 137, foodstuffs 230.
Instruments, meteorological 325.
Isothermal 336.
Kala azar 452.
Koch's rules 401, 106.
Land treatment 261.
Latrines 233.
Lead in water 88.
Leishmania 457.
Leprosy 431.
Liernur system 256.
Lighting 19, 54.
Lodging houses (pilgrims) 135.
Maize 161.
Malaria 439, 457.
Manhole chamber 247.
Marriage rate.
Masak 94.
Measles 417.
Meat 149, 203, 214.
Medicine, state 1.
Meteorology 325.
Meter, water 87, 83.
Middens 227.
Milk 143, 209, 214, supply, control of 198.
Millet 161.
Mines, ventilation of 28.
Moisture—see humidity
monsoon 345.
Mosquito 443.
Mountain, climate of 338, 357.
Mumps 420
Natural resistance 401
Nuisance 56, of slaughter house 60, of trade 56.
Nuts 167, 217.
Oats 161.
Offensive trades 56.
Opsonin 403, 405.
Oxyuris vermicularis 460.
Pail system 227, 229.
Parasites, human, 455.
Parotitis epidemic 420.
Pertussis 418.
Pestis 436.
Pettenkoffers test—see appendix.
Phthisis 425.
Pigstye 58.
Pilgrim lodging houses 135.
Pilgrim places in India 364.
Pipes, laying of 245.
Pitting system 239.
Plague 436.
Plenum system 43.
Plumbo solvency of water 88.
Pollards 158.
Population, estimation.
Potato 163.
Poudrette 230.

Privy 233, service 227.
Precipitin 406.
Preservation of foodstuff 208
Proximate principles 138.
Pulses 215, 162.
Purification of water 95.
Rain 68, 69, 331, 343.
Rats and plague 436.
Reservoirs of water 71, 85.
Rest and sleep 303.
Rice 156, 161.
Rideal-Walker 468.
River water 73.
Roots and tubers 163, 216.
Sonatoria, tuberculosis 427.
Saturation—See Humidity.
Scarlatina 416.
Scavenging 223.
School hygiene 306.
Sea voyage 355.
Septic tank 269.
Sewage, 259. Farming 261.
Sewer 249. outfall of 252.
Sherringham's Valve 39.
Shell fish 153, 208.
Ship, ventilation of 28, disinfection of
Shone system 256.
Side chain theory 409.
Slaughter house 58, nuisances of 60.
Sleeping sickness 452.
Slop closet 234, sinks 235, waste pipe 243.
Small pox 414.
Smoke nuisance 27.
Smoking 285.
Soap 287.
Soil 115, 117, 12, 13.
Spirochætæ 256.
Spring water 74, In India 364.
Stable 57.
Subsoil water 119, 123.
Sugars 179, 216.
Supersensitization 410.
Syphilis 430.
Tæniæ 458.
Tank water 72.
Tea 174, 213.
Thermometers 326.
Ticks 463.
Tobins Tube 40.
Toxin 399.
Trade nuisance 56, diseases due to 14, dangerous 63.
Transcalency 335.
Traps 239.
Trenching 231.
Trichina spiralis 205, 462.
Trypanosomes 456.
Tuberculosis 425, 205.
Tunnels, ventilation 28.
Typhoid fever 421.
Urinals 235.
Vaccination 411, 415.
Varicella 419.
Variola 414.
Vegetable foods 154.
Ventilating grate 50, stove 51.
Ventilation 25. of sewer 253.
Ventilators 39, 42.
Vineagar 179.

Vital statistics.
Vitamines 142.
Walls, hollow 130.
Warming 48.
Water 65, 168, amount required 82, carriage of sewer 232, classification 95, closet 233, examination of 80, 107, impurities 91, 113, mains 88, purification 97.
Well privy 229.
Wells 75, 98.
Wheat 157, 161, 211.
Whooping cough 418.
Winds 46, trade 344, local 345.
Wines 213, 218.
Working classes, houses for 134.
Yellow fever 451.
Zygotes 441.
Zymotic death rate.

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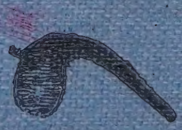

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